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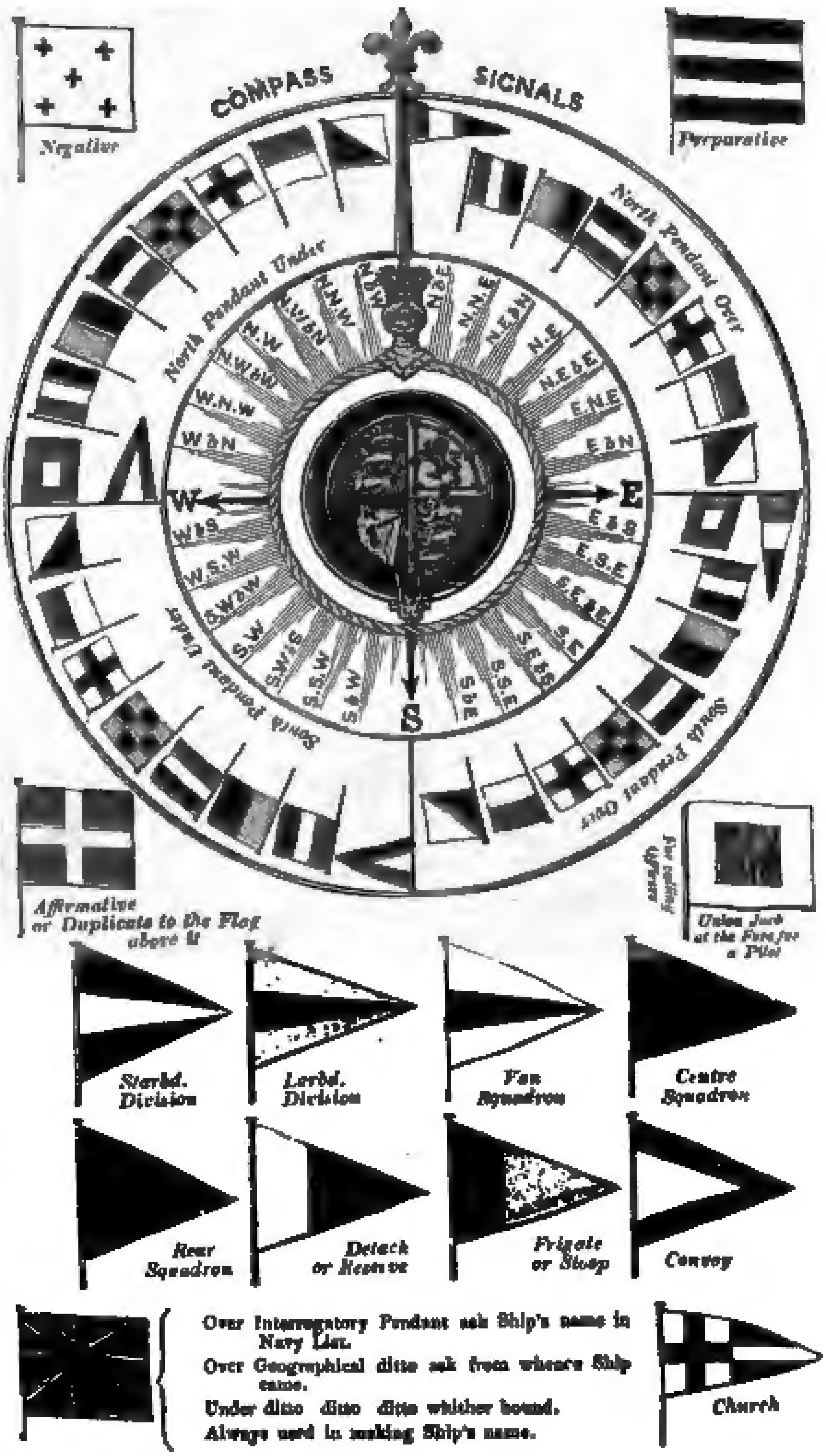
COMPASS SIGNALS
Negative
Preparative
North Pendant Under
North Pendant Over
South Pendant Under
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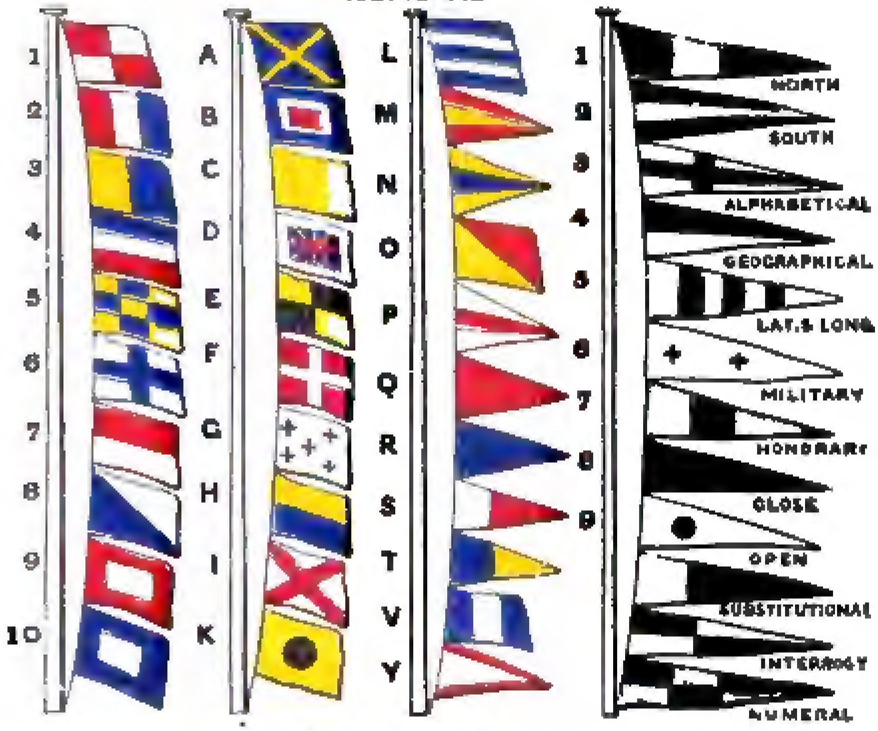
W
E
S
Affirmative or Duplicate to the Flag above it
Union Jack at the Fore for a Pilot
Starbd. Division
Larbd. Division
Van Squadron
Centre Squadron
Rear Squadron
Detach or Reserve
Frigate or Sloop
Convoy
Over Interrogatory Pendant ask Ship's name in Navy List.
Over Geographical ditto ask from whence Ship came.
Under ditto ditto ditto whither bound.
Always used in making Ship's name.
Church

NUMERAL



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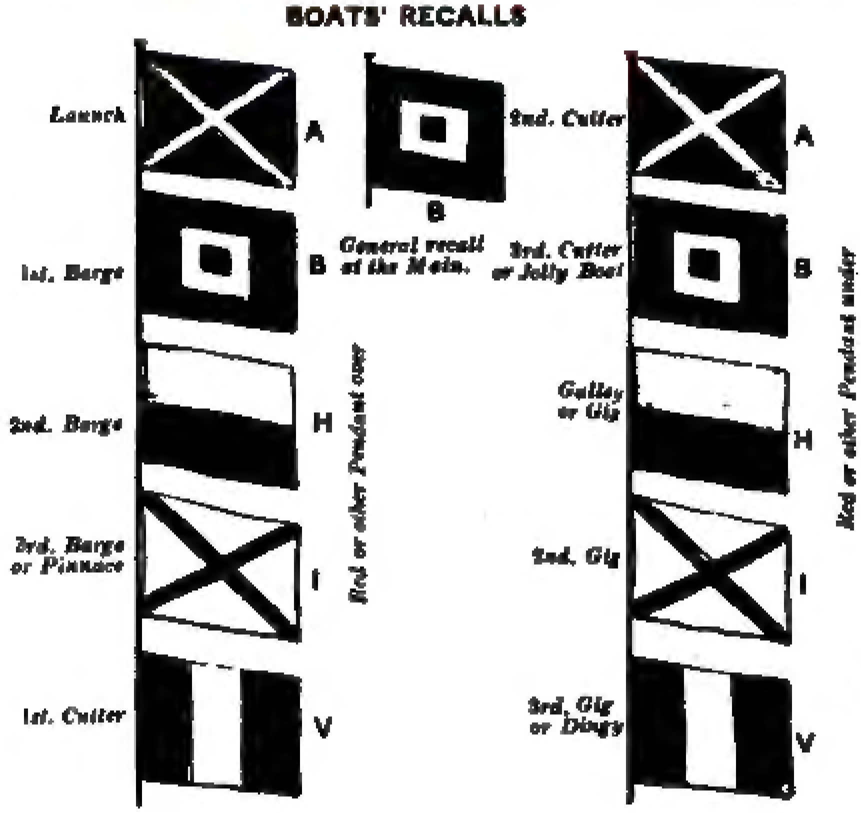

A

MANUAL FOR NAVAL CADETS.

BY

JOHN M'NEILL BOYD,

CAPTAIN R.N.

"And well the docile crew that skilful urchin guides."

BYRON.

LONDON:

LONGMAN, BROWN, GREEN, LONGMANS, & ROBERTS.

1857.

TO

THE RIGHT HON. SIR CHARLES WOOD, BART., G.C.B.

FIRST LORD,

AND THE OTHER

LORDS COMMISSIONERS OF THE ADMIRALTY,

THIS BOOK,

PUBLISHED UNDER THEIR SANCTION,

IS RESPECTFULLY

Dedicated,

BY THEIR OBEDIENT SERVANT,

THE AUTHOR.

PREFACE.

This work advances no pretensions to originality. It is what its title indicates — A Manual. The subjects, therefore, of which it treats, must more or less have been handled before, and, no doubt, more ably, fully, and clearly. The scientific and mechanical explanations, which the writer has found it necessary to give in different parts of his work, are of course little more than repetitions of definitions and principles which many treatises supply; and if, in the statement of such principles, well known terms and formulæ of expressions have been employed, it must be recollected, that the language of science is technical, and from its arbitrary precision forbids the use of any tongue but its own.

The Publication of such a book may seem to require explanation, if not apology; and perhaps the best one the writer can give, will be found in the circumstances which suggested the work, and which have led to its appearance in print.

In the course of a somewhat long and arduous professional career, the writer discovered, not unfrequently, considerable ignorance prevailed among Naval Cadets on points intimately connected with their duties. This may have arisen partly from their education, previous to entrance in the service, not being made to bear directly on its requirements, partly from the extensive range of information on various subjects required in a naval officer, and partly

from the want of some plain works containing a good deal of instruction in short compass. As the writer has ever taken a lively interest in the improvement of young officers under his command, he was induced not only to direct their studies generally, but to assist them in those studies by a supply of papers, diagrams, and illustrations, calculated to throw some light on the subject before their minds. These papers grew upon his hands, and suggested the idea that, if collected and arranged, they might be of more extensive use to those youthful members of the profession for whose advantage they had been originally prepared; and that without the slightest intention of authorship.

Under these impressions, the writer felt it his duty to place the following papers before the Lords of the Admiralty, leaving it to their judgment to decide whether they were likely to contribute towards the end desired, or whether they were only worthy of place among other well intentioned but useless writings which never see the light. Being himself entirely unambitious of the honour of authorship, and conscious that his etchings had but little claim on the favourable consideration of the public, he was contented to leave the question in the hands of his professional superiors, as an evidence, at all events, of his desire to serve a profession to which he has been all his life ardently attached.

The decision of their Lordships left him no choice as to further steps. They were pleased to express a judgment that the pages laid before them were calculated to be useful, to intimate their approval of their contents, and to evince that favourable opinion in the strongest manner in their power by voting a sum of money towards the publication of the work, and still further by ordering a number of copies on their own account.

This act, as liberal and encouraging on the part of the

Lords of the Admiralty as it was flattering to the compilation they had been pleased to honour with their approval, necessitated its publication. The Author felt that it would be but a doubtful proof of the attachment he feels for the service to which he belongs were he from apprehension of criticism, or feelings of false delicacy, to suppress a work which his superiors have honoured with their commendation.

In the handling of the several subjects the Author desires to express his obligations to those professional friends who have conferred upon him the benefit of their remarks on some points which he was permitted to bring under their personal notice.

In using certain expressions, such as "ought," "should," &c., the Author is anxious to disclaim anything approaching to a tone imperious or dictatorial. He does not affect to prescribe to any what should be the line of conduct adopted, but simply means to convey that, according to his ideas, the course or acts suggested are the proper ones to be taken under the circumstances.

It will also be observed that in some chapters the ordinary style of this work has been departed from, and another more involving personal address substituted. The Author found that, in laying down directions for the performance of certain routine duties, it was more convenient and condensed to suppose himself speaking to those for whose benefit his book is intended, than to clothe these necessary directions in a style abstract and more diffuse. In fact, when duties such as the "handling" of gear came to be specified, it was found impracticable to convey directions in any other mood than the imperative.

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A

MANUAL FOR NAVAL CADETS.

CHAPTER I.

WATER AND AIR.

Theory of naval architecture is founded on those branches ... -ntery fluids which are comprehended in the ... —Hydrostatics, which treat of ... aulics, which treat of them in ... at of the pressure and motion

... is water? and what is air? ... nder the cognisance of our ... up of atoms, each of which, however minute, ... h, and thickness, and occupies a space into which another cannot enter until the first has been displaced. If, for example, we immerse a solid in a vessel full of water, a portion will overflow equal in bulk to that of the body which is submerged. This property of matter is called its Impenetrability.

In some bodies the atoms are closer together than in others, and, although of similar volume, would have greater gravity. This is the Density of matter.* The quantity of space which

* The earth is a mass of matter, about 5⅔ times heavier than an equal volume of water; or, what is the same, the mean density of the earth is 5⅔. The total weight of the earth is more than 6,000,000,000 billions of tons.

a body occupies, is called its Volume or Bulk. All bodies on or near the earth possess gravity (or weight), and tend towards the earth's centre with a force called centripetal, proportionate to their respective densities. Fluids press equally in all directions, upwards, downwards, obliquely, or laterally. Solids press only downwards. The pressure of a fluid on a lighter body, or a rarer fluid, arises from the heavier fluid seeking to maintain its own level, or the level of its own weight. The extraneous body is therefore driven upwards, as in the case of gases, steam, vapour, smoke, &c.

Most substances are made up of two or more others, so intimately associated, either by mechanical mixture or by chemical combination, as not to be separable, except by extraordinary means. The component parts are held together by an attractive force called "Cohesion," which is greater in solids than in fluids, and altogether absent in gases. When solids are exposed to a certain degree of heat, they change their state : some are converted into liquids ; liquids into vapours ; and again, by a like loss of heat, these revert to the liquid state ; and liquids, by due degrees of cold, are solidified. In others, the conversion is into smoke. This property of matter is called its "extension." In some cases these substances may be taken to pieces, and each part further investigated — a property of matter which is called its Divisibility ; but when they resist all separation, they are called simple or elementary.

Those substances which it most concerns us to consider in reference to the question we are investigating, are oxygen, nitrogen, and hydrogen.

Oxygen is only known as gas. It is a little heavier than atmospheric air, and 740 times lighter than water. It is the principle of combustion or burning, and indispensable to the support of animal or vegetable life. All substances which are capable of combustion in common air, burn with far greater intensity in an atmosphere of pure oxygen ; but were it inhaled by animals in this form, they would expire from excess of vital action.

Nitrogen, or azote, has neither colour, taste, nor odour. It extinguishes flame, cannot support life, and counteracts the activity of oxygen in that mechanical mixture of these two gases which compose our atmospheric air.

Hydrogen is the lightest and most inflammable of all material substances, being bulk for bulk more than fourteen times as light as common air: 2000 feet of this gas will weigh only 11 lbs.; while the same volume of common air will weigh 160 pounds. For this reason, it is used in the inflation of balloons. Phosphuretted hydrogen is generated by the decomposition of animal bodies, and has produced such phenomena as the "Will o' the Wisp," &c. Sulphuretted hydrogen is extremely poisonous, and is generated freely during the combustion of tallow or wax candles.

During consumption by fire, fermentation, or decay of organised bodies or vegetables, as well as during the respiration of animals, carbonic acid gas is constantly produced. It is also thrown off by vegetation during the night; but its noxious effects upon the atmosphere are neutralised by the larger quantities of oxygen which plants generate in daytime. It extinguishes light, and produces suffocation. Being heavier than air, it remains at bottom of wells and mines, causing the "choke-damp," which, however, may be dispersed by throwing in water. A compound of this gas with hydrogen, called carburetted hydrogen, issues from stagnant waters, decomposed matter, and under the name of "fire-damp," produces explosions in coal mines.

Air from the lungs of animals, when breathed a second time, acts as a poison, which is more or less deadly as the oxygen is more or less vitiated. A man consumes 26 cubic feet of oxygen daily, and generates nearly a cubic foot of carbonic acid hourly. Wood, much saturated, absorbs oxygen, and thus generates carbonic acid gas; and all vegetable matter emits carbonic acid at night. These are facts which naturally present serious objections to unnecessary exposure in night-boatwork on rivers, and too frequent deck-washing: as well as enforce every possible contrivance for ventilation.

"To form just conceptions of what Ventilation is, and how it is in general to be accomplished, an engineer has to consider that the ocean of air, called the atmosphere, which rests on the surface of the earth, and at the bottom of which men live, as certain aquatic animals live at the bottom of the sea, is about 50 miles high or deep; and that the portion of this ocean which can be contaminated by any process of animal or vegetable life, or by the decomposition of organic bodies when dead, may be

regarded as less deep generally than the fiftieth part of one mile, estimated from the surface of the earth. This comparatively insignificant stratum, therefore, may be regarded as the home or lurking place of all epidemic diseases and insalubrious air; the more exact statement, indeed, being, that these are generally confined to the still much smaller portions of air contained in houses, or other enclosed places. Then the fact is to be kept in mind, that the whole mass of the atmosphere at any moment over a city or other place, is always travelling away to leeward, with the speed of the wind, and is carrying with it whatever impurity may ascend from below, which impurity is then resolved quickly into the pure elementary oxygen, carbon, &c., of which all effluvia consist. Man can no more contaminate permanently the deep atmosphere over him by his proceedings at the bottom of it, than he can contaminate the Atlantic Sea, by what he may do on the shores. Then he has to learn, *with the same mechanical certainty* as he can substitute the pure water of a passing tide or river stream for defiled water near the shore, *he may substitute pure air from the atmosphere* for any air near him *that has become unfit for his use.*"*

These substances enter into the composition of water and air, though in different proportions. Water consists of eight parts by weight of oxygen and one of hydrogen, and air mainly consists of one measure of oxygen, to four of nitrogen. Both are fluids, and have many properties in common. The watery ocean extends over three parts of the earth's surface, and the aërial surrounds the globe to a height of 45 miles.† Both have impenetrability, inertia, and momentum. Bodies, specifically lighter, float upon their surface, and heavier bodies sink. Both gravitate towards the earth's centre, and press equally in all directions. This equality of fluid pressure on the bodies of animals

* Arnott.

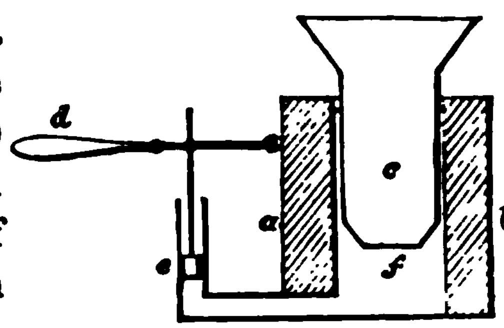
† The surface of the sea is estimated at 150 millions of square miles, taking the whole surface of the globe at 197 millions. The Pacific Ocean covers 78 millions of square miles, the Atlantic 25, the Indian Ocean 14, the Southern Ocean to 30 degrees 25, the Northern Ocean 5, and the Mediterranean 1 million; the Black Sea 170,000, the Baltic 175,000, the North Sea 160,000.

The depth of the ocean is one of those secrets of Nature which the ingenuity of man has failed as yet to penetrate. It has been inferred from a supposed physical relation that it is equal to the height of the mountains. Lieut. Maury does not consider this supposition, or the different reports of soundings which have exceeded 25,000 feet, to be deserving of confidence.

is sustained by the counteraction of fluids contained in their system; and when the water inside a ship has risen above the level of a leak, the entrance of more will be considerably retarded. "This equality of pressure in all directions at any point in a fluid in equilibrium, is the fundamental principle from which all the reasonings of hydrostatics are to be deduced. The particles glide over each other with perfect freedom, each particle pressing equally on all the particles that surround it, and is equally pressed upon by these. It also presses equally upon the solid bodies which it touches, and is equally pressed upon by these."*

This property of thus transmitting pressure, is one in virtue of which a liquid becomes a machine; for if a quantity be submitted to compression, the effect is equally diffused through the whole; and a given pressure, made on one inch of the surface of a fluid contained in a vessel is instantly borne by every inch of the surface of the vessel, however large, and by every inch of the surface of any body immersed in the fluid. Thus, in the hydrostatic press, which is used in the process of forcing the preservative solution into timber, if the small piston of *e* (*Fig.* 3.) have only one thousandth of the area of the larger one, *c*, and be pressed down with a force of 500 lbs., it will cause the large one to rise with a force of 1000 times 500 lbs.* In the construction of the Britannia Bridge, a press of this kind was made use of, which lifted a weight of 1,144 tons. The internal diameter of the great cylinder was 22 inches, and that of the ram or smaller piston, 20 inches.

Fig. 3.



Water is of the same density throughout, and is incompressible. Air has different degrees of density, and is elastic. To the general law that heat causes expansion, and cold contraction, water is but partially obedient, while air obeys that law under all conditions. A cubic foot of distilled water weighs 1000 ounces avoirdupois. Sea water contains from 3 to 4 per cent. of salt. Fresh water boils at 212° Fahrenheit, and begins to freeze at 32°. Sea water freezes at 28½°. At this point, the atoms become fixed

* Arnott's Physics. Tomlinson's Nat. Philosophy.

in crystals, and continue to expand until they form ice; which being 8 parts in 100 lighter than water, floats on its surface.* Nine cubic inches of water become ten by freezing; and a cubic inch, confined and frozen, expands with a force equal to nearly 13 tons, — a fact which, if not considered in the arrangement and management of those pipes and valves which in ships communicate with the sea, may lead, and has led, to dangerous accidents.†

Bodies of greater density than water, when completely immersed, lose just as much of their weight as that of the quantity of water they displace; a consideration intimately affecting all such operations as the carrying of guns, anchors, rudders, &c., underneath boats, or weighing sunken vessels, &c.

CHAP. II.

DISPLACEMENT AND SHAPE.

Bodies which float on the surface of water are borne upwards by a force equal to the weight of the fluid displaced; but those bodies whose bulk does not displace a quantity of water equal to their weight will sink, unless floated in a vessel sufficiently large to displace a quantity of water heavier than their united weights. A ship, therefore, destined to carry a certain amount of tonnage, must be so constructed as to displace a quantity of water equal to that, and her own weight besides. This consideration involves the distinct connection of hydrostatics with naval architecture, especially as affecting the subject of displacement.

* Liebig tells us that "during the act of freezing, the temperature remains at 23° Fahrenheit. Nevertheless water may be cooled as low as 5° without becoming solid, if the fluid be in a state of perfect rest, but that the least disturbance is sufficient to effect congelation."

† Ice 2 inches thick will bear Infantry.

4	"	Cavalry or light guns.
6	"	Field-guns (heavy).
8	"	24-pounders on sledges.

U. S. Manual.

Floating bodies immerse a portion of their bulk in the fluid on which they are borne. They float because they are specifically lighter than the fluid; that is, a given mean measure of the one is lighter than a given mean measure of the other. On placing such bodies on water, they sink until a balance is established between their weight and that of the water pushed aside to permit its immersion. The portion immersed displaces exactly its own form and bulk of the fluid; and the weight of that bulk of fluid is precisely equal to that of the floating body. The body being the ship, and the fluid, water, the amount of water thus removed will be her "displacement." The number of cubic feet contained in the body below its line of flotation is obtained from the drawings, and will be the exact measure of the quantity of water displaced. Then the weight of a given measure of water being known, the weight of the quantity of water displaced (and consequently the weight of the floating body at any line of flotation) may be known also. But this is a simple question of mensuration. The builder is not to accomplish his work simply in reference to the quantity of materials he has at his command. He has a certain amount of weights in the form of men, guns, masts, and stores (according to the *rate* of the ship ordered to be built), given him as data of procedure, and he must so manage his material, as to produce a structure capable of accommodating those weights, without detriment to the necessary amount of buoyancy. There is little or no remedy if the attempt turn out a failure. If on being equipped, it appears that the form and dimensions of the part immersed are not such as to displace a quantity of water equal to the weight of the ship and her material, the ship will sink so low in the water, as to be inefficient for her purpose; and she must in that case be reduced to a lower rate by the withdrawal of a certain quantity of guns, ballast, and stores. On the other hand, if it appears, on being equipped, that the form and dimensions of the part immersed are such as to displace a greater weight of water than that of the ship and her material, she will be so high as to be crank, leewardly, and otherwise defective. It would be needful in this case to increase her ballast and other weights to a degree that would affect her sailing qualities. This discrepancy might be owing to ignorance or miscalculation on the part of the architect, or to mistake or fraud on the part

of the shipwright; for there must not only be propriety of dimensions, but suitability of materials. In other words, the dimensions may be out of proportion for the purpose for which the vessel is required; or the scantling may be stouter or slighter, the timber greener or better seasoned, or specifically heavier or lighter.

Having thus briefly considered the subject of the ship's capacity, it is desirable to treat of that of Shape, a question which involves the laws of hydraulics. We know that water in motion presses more or less upon an obstacle exposed to its action, according to the position and form of that obstacle; and that an object moves through water at rest with more or less facility, according to its shape. The hand placed in running water perpendicularly or horizontally, offers different amounts of resistance; and, moved in that position through still water, encounters different amounts of resistance. The great question then to determine was that of the form of a vessel which would oppose to the water the least possible resistance; and to that question have our various schools of ship-building applied themselves with more or less success. Bluff bows and fine runs, "the dolphin's head and mackerel's tail," were for a long period considered the main desiderata. The "bruise waters" gave way to "long bows and full after-bodies;" the "long hollow floor" to the "peg-top" pattern; narrow "cribs" to excessive breadth of beam; light draught of water to deep draught; and enormous quantities of ballast to none whatever. Each and all of these systems have had their respective advocates; all bent upon ascertaining that particular form which could be most easily propelled, or in other words offer the least resistance.

Numerous experiments were made with a view of solving this question. Pieces of wood of equal bulks, but of different shapes, were drawn across the surface of a water trough by equal powers of traction, and that which performed the transit in the shortest time was considered to have furnished the desired model. But when this shape came to be tested by the ruder trial of practice, it was found to be a success only under partial circumstances. In strong breezes and smooth water it succeeded to admiration; but in opposite circumstances, and with a propelling power acting in any other direction than the parallel, it proved to be a failure. The reason of this soon became obvious. Sufficient

consideration had not been bestowed on the fact that a vessel's lines and shapes alter relatively to the state of the water through which she moves. In other words, the ship which opposed comparatively little resistance to a smooth sea, presented unexpected resistance to a broken one. The forms of fish again were supposed to supply the desired pattern ; but here it was overlooked that the rapidity of the motion of the fish probably depends quite as much on muscular power, as upon peculiarity of shape. In the case of birds, for example, it is notorious that speed of flight does not always depend on equality or even similarity of bulk. All this tends to prove, that while great importance is to be attached to the question of shape, no degree of excellence in that respect will necessarily ensure rapidity in sailing. That depends on many considerations besides; such as the adaptation of the weight to be carried to capacity and form; the distribution of that weight in the vessel; harmony between shape and rig ; and, above all, the handling of the ship. Craft of undoubted speed have ceased to be constant winners after a change of owners ; and some of the old school ships have held their own with modern ones. That may be the result either of seamanship or of trim, or of both, — questions which will come more appropriately under notice in a different section.

One fact has been established by experiments made in reference to the question of form in our own days. It has been proved that (due attention being paid to construction) rapidity of sailing is in proportion to increase of bulk. Of this our own navy exhibits many illustrations. To select one—the Duke of Wellington is equally remarkable for speed and handiness; proving that as far as her dimensions have gone, increase of size promotes rather than hinders velocity. But the most remarkable application of the theory which modern times furnishes is presented in the instance of the "Great Eastern," now in process of construction.

In the case of this vessel, it has been carried to such a singular extreme as to warrant notice. Her distinguishing feature is length. The Atlantic waves are calculated rarely to exceed 28 feet in height, and 600 in length, whilst in moderate gales, they are but 300, and in fresh weather about 120 feet in length; and it is expected that as the ship will be water borne, even in extreme circumstances, by two waves at the same time, she will

bestride the heaviest seas, and thus avoid those descents into the troughs which compel shorter vessels to traverse additional space, and so lose time in struggling upward against a powerfully resisting medium. The annexed sketch (*Fig.* 4.) is on a scale of proportion.

The ship is of iron, 692 feet long over all, 83 feet beam, 114 feet across the paddle-boxes, and nearly 60 feet deep: the sides are tied together by double decks, and 10 transverse bulk-heads.

As to the comparative excellence of wood and iron in ship-building, Mr. Fairbairn remarks: "Iron ships of the same external dimensions as wooden are both lighter and stronger, and consequently have more space for cargo. Their original cost is less, but their comparative durability is not yet decided."

But the whole of this subject of ship-building, with reference to the question of fluid resistance, is admitted by the most eminent writers and the more experienced practical men to be one, even now, of extreme difficulty. The creation and failure of the several schools of naval architecture are but so many steps towards the ultimate discovery of the right form according to which ships should be constructed. Builders of high reputation have carried out their own theories only to arrive at the discovery that results did not correspond to the expectation. Naval men have done the same, and with the same result. Both —the scientific architect and the practical seaman—have found out that scientific knowledge, and practical experience, *separately*, have failed to solve the problem. It was probably this which led Mr. Fincham to say:—"The theory of resistances remains in about the same condition that it was left by Du Buat, and experiment has done little since the date of Colonel Beaufoy's labours. . . . . . And until the perfection of a theory of naval architecture shall have been sought in new inquiries on this subject, the naval architect must look chiefly to the navy itself for suggestions to improve the forms of ships."

This last acknowledgment appears to suggest the only probable plan for the construction of vessels answering under trial to the theoretic anticipations of their designers. That which has failed under separate talents, may possibly succeed under conjoint ones. Abstract science and personal experience may, when combined and assistant to each other, give us the great desideratum. Since the above quotation was written, we

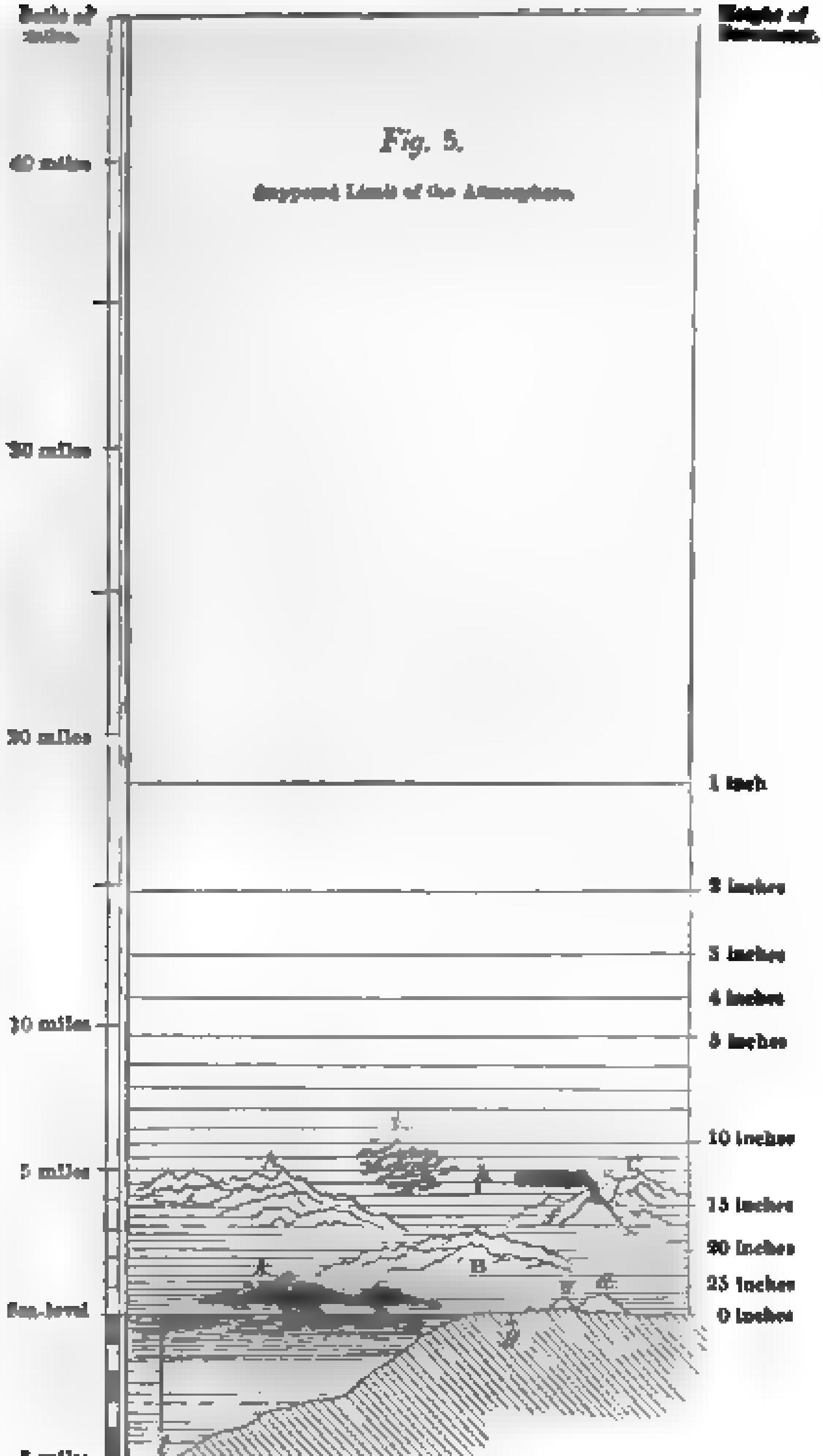


Fig. 5.

	Feet.
...imalaya - -	28,000
...lps (Mont Blanc) -	15,650
...ndes (Sorata) -	25,250
...en Nevis . - -	4,350
...owdon - - -	3,557
...umboldt and Bonpland on Chimborazo	18,376

	Feet.
g. Dalkeith Mine, Cornwall - - -	1,440
h. Gay-Lussac's Balloon Ascent, in 1804 -	23,000
i. Cirri, or Mare's Tail Clouds -	20,000 to 30,000

	Feet
k. Rain Clouds 1,000 to	7,000
l. Deepest Sounding by Ross, in the Third Antarctic Voyage -	27,600

Air conveys heat, but is a bad conductor of it. The solar rays pass through it, and their heat is radiated from those bodies (as earth and sea) on which they fall. Hence, the lower strata are first heated, and, being thus rarefied, necessarily ascend, their place being supplied by colder ones. Some quarters of the globe — as the equatorial regions — receive more heat than others. Land derives more heat from the sun during the day than sea, and cools more rapidly during the night. Currents of air are thus created, and this is the chief cause of such periodic winds as trade winds, monsoons, land and sea breezes. Sir Humphry Davy says, "the immediate cause of the phenomena of heat is motion, and its laws are precisely the same as those of the communication of motion:" and another writer remarks that "every body moved in a right line and continually reacted upon, is necessarily turned into a circle; every atom projected with velocity into a medium of atoms, is necessarily turned into an orbit, greater or less as the force of the projection, or the intensity of the atomic motion called heat. When reduced in bulk, the orbits are reduced, and their motion or heat imparted to other bodies around."

This rotatory motion, gathering force from opposition, from collision with currents of different densities and gravities, or from the results of rarefaction, is presumed to be the leading cause of whirlwinds and hurricanes. In application of the subject of hurricanes to the management of vessels, Colonel Reid recommends that a ship caught on the right side of a hurricane be put on the starboard tack, and when caught on the left side, on the port tack, as the wind will gradually draw aft, and the danger of the ship being taken aback by its heading will be thus avoided. It would carry us beyond the limits of this work to enter at length on the consideration of the important subject of the nature and laws of these revolving storms. Nor is it necessary to do so, as that subject will be found lucidly treated of in a short pamphlet published by order of the Lords Commissioners of the Admiralty *, and also in a work written by an American officer.†

* "Remarks on Revolving Storms."

† The "Physical Geography of the Sea," by M. F. Maury, LL.D., Lieut. U. S. Navy. In this admirable book, the author—a brother sailor—has included a philosophical account not only of the winds, but also of the currents of the sea, its temperature and depths, the wonders that are hidden

The subject of the velocity of wind as demonstrated by its perpendicular pressure on the square foot, has come under the experiments of Mr. Smeaton. To him we are indebted for the following table, intended to show these relative proportions, and so to give an adequate conception of the force of air in motion. The first column shows its velocity, and the second its power of pressure.

Miles per hour.	Perpendicular force on one square foot in pounds avoirdupois.	
1	0·005	Hardly perceptible.
2	0·020	Just perceptible.
3	0·044	
4	0·079	Gentle.
5	0·123	
10	0·492	Brisk.
15	1·107	
20	1·968	Very brisk.
25	3·075	
30	4·429	High wind.
35	6·027	
40	7·873	Very high wind.
45	9·963	
50	12·300	Storm.
60	17·715	Great storm.
80	31·490	Hurricane.
100	49·200	Violent hurricane.

The principal use to the sailor of that well-known instrument ...ter is to announce atmospheric changes, and so ...ms. Many instances are on record of seamen ...tions, warned of the approach of danger ...thing in the appearance of the sea or ...refore be instructive to devote a

...at its surface; and this in ...ut especially instructive ...le has fairly

page or two to the explanation of its principles and construction; premising that in, or rather at the approach of, foul weather, the atmosphere is lighter, and in fair weather heavier.

The weight of the atmosphere may be ascertained by placing an exhausted tube in a vessel filled with fluid. The fluid being forced by the atmospheric pressure on its surface, will mount into the vacuum, till the weight of the air and that of the fluid in the tube balance each other; the fluid in the tube will then represent a column of air of the height of the atmosphere, and the diameter of the tube. Water, under the weight of the air, will rise in a vacuum to a height of 34 feet. But mercury being 13 times heavier than water, will only rise $\frac{1}{13}$ part of that quantity. This is the principle, on which the barometer is formed. A glass tube, usually 36 inches in length, and one-third of an inch internal diameter, closed at one end and open at the other, is dried, and, care being taken to prevent the introduction of air, filled with quicksilver under an exhausted receiver. The open end is then stopped, the tube inverted and plunged upright in a vessel full of quicksilver. The stopper being taken out, the quicksilver in the tube will fall until it is balanced, leaving the upper end in vacuo. The weight of this column of quicksilver will be about 15 pounds, and its height about 30 inches. Were the tube sufficiently long, and water employed instead of mercury, it would be supported at a height of 34 feet. If a barometer were carried to any high position, the mercury would fall in proportion to the height, indicating thereby a decrease of atmospheric pressure. In this way, making allowance for variation of temperature, the height gained is at once indicated.

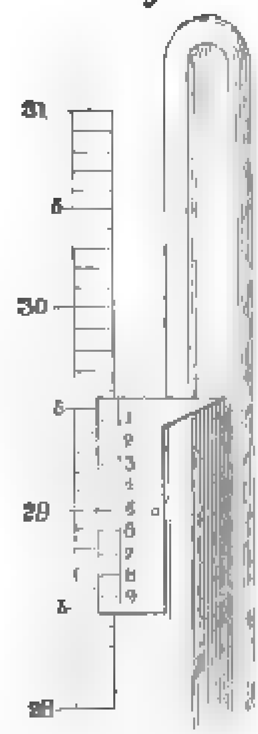
It will be observed that the surface of the mercury is convex when ascending, concave when falling; a difference arising from friction, or a tendency of the particles of quicksilver to cling to the sides of the tube.

The height of the mercury in the tube is measured by a scale of inches divided into tenths, and by the *Vernier*, which is a scale of eleven tenths divided into 10 equal parts, so as to divide the scale of tenths into hundredths. By this arrangement we obtain the broad or rough height of the mercury, and (when extreme precision is required), the additional fractional quantities. The vernier being moveable, is adjusted to the level of the mercury, and the number of degrees between that level and the last degree

on the barometrical scale, which the mercury has passed, represents exactly the ascent or depression of the fluid.

In the figure the height of the column is more than 29·5 inches, but less than 29·6. In order to measure the hundreths of an inch, we place the zero or top of the vernier scale exactly level with the top of the mercury, and observe that of all the lines on the vernier only one can coincide with a line on the scale. In the figure the line marked 6 on the vernier, coincides with a line on the scale: and as from the top of the mercury to these coincident lines there are 6 pairs which do coincide, and as each pair deviates by $\frac{1}{100}$th of an inch more than the pair below it, the uppermost pair must evidently differ by $\frac{6}{100}$ths of an inch. We thus get the height of the mercury in one figure, which is 29½ inches, and $\frac{6}{100}$ths inch; or, expressed decimally, 29·56.*

Fig. 6.



In his " Directory for the Pacific Ocean," Mr. Findlay observes: " The barometer measures the weight of the atmosphere above its place, in exactly the same manner that other ponderables are weighed in a balance. The weight of the column of mercury in the tube is exactly equivalent to that of a column of air of similar diameter the height of the atmosphere; therefore, any change in the one affects, or is affected by the other. Now it has been found that strong winds lower the barometric column, therefore there is less superincumbent air at those times; and this principle indicates some of the atmospheric conditions which forebode the approach of or alteration in a storm. The mean height of the barometer varies considerably in various parts of the world, and therefore its changes, rather than its absolute height, is the most important consideration." " The barometric scales, as arranged in Europe for European purposes, have a tendency to mislead : fair, change, set-fair, or stormy, mark the

* See Tomlinson's Pneumatics.

heights of the mercury indicative of a totally distinct character in the atmosphere in the tropical regions or elsewhere, and ought therefore to be disregarded or obliterated from those barometers which are to be used in other regions. It is perhaps to this cause that the opinion is owing that the barometer is useless in these parts." The same writer remarks, "The great advantage of the *Aneroid Barometer*, is, that being more sensitive than the mercurial one, its variations occur simultaneously with their causes. Its mechanism consists of a small metallic cylinder, which is exhausted of its internal air. The sides of this cylinder are prevented from collapsing by a series of springs and levers, which latter act on a moving hand, showing the equivalent of the height of the mercury in an ordinary barometer. The differing atmospheric pressure on the exhausted cylinder causes its sides to close with greater, or the springs to separate them with less, external pressure, thus varying the index with the condition of the atmosphere. Like other pieces of mechanism it is liable to derangement, and, as in the case of chronometers, unless some means be used to detect any variation from the correct standard, they must not be implicitly relied on. It must therefore hold the relative value to the mercurial barometer that the job watch does to the ship's chronometer. By testing its action, and remarking its variable index error by the ordinary barometer, it will hold a high place among the useful instruments to aid navigation." *

The *Thermometer* is an instrument founded on the principle that most bodies — fluids especially — expand by heat and contract by cold. It is used for the purpose of measuring the amount of heat in the atmosphere, or other substances brought into contact with, or the vicinity of it. In construction it differs from the barometer in having the tube closed at each end. The mercury contained in the tube moves in a vacuum, caused by the expulsion of the air by boiling the mercury, and then closing the top of the tube by means of the blow-pipe. There are three descriptions of thermometers in common use, all constructed on the same principle, but differing in the divisions or graduations of their respective scales. Fahrenheit's thermometer is generally used in this country, and Reaumur's and Celsius's (or the Centi-

* Directory for the Pacific Ocean, p. 1209.

grade) on the Continent. To convert degrees of Reaumur into those of Fahrenheit, the most convenient rule to follow is to multiply by 9, divide by 4, and add 32 to the quotient; or, after multiplying and dividing as above, to subtract 32 from the quotient, as the degrees may be positive or negative. Thus,

$$28^\circ \times 9 = \frac{252}{4} = 63 + 32 = 95^\circ;$$

or,

$$28^\circ \times 9 = \frac{252}{4} = 63 - 32 = 31^\circ.$$

And to convert degrees of Celsius into those of Fahrenheit, the following rule may be adopted, namely: Multiply by 9, divide by 5, and add or subtract 32 to or from the quotient, as the degrees may be positive or negative. Thus,

$$35^\circ \times 9 = \frac{315}{5} = 63 + 32 = 95^\circ;$$

or,

$$35^\circ \times 9 = \frac{315}{5} = 63 - 32 = 31^\circ.$$

The following table will give at one view the comparative degrees of these three instruments from 212° Fahrenheit to 32°, or freezing point.

Reaumur.	Centigrade.	Fahrenheit.	Reaumur.	Centigrade.	Fahrenheit.
80	100	212	36	45	113
76	95	203	32	40	104
72	90	194	28	35	95
68	85	185	24	30	86
64	80	176	20	25	77
60	75	167	16	20	68
56	70	158	12	15	59
52	65	149	8	10	50
48	60	140	4	5	41
44	55	131	0	0	32
40	50	122			

The principal uses of the thermometer on board ship are to determine the state of temperature between decks and in the engine room; to indicate the approach of icebergs, and to mark the stages of the conversion of water into steam.

In keeping the Journal, for the sake of brevity, the force of the wind and state of the weather are expressed thus :—

WINDS.

0. Calm.
1. Light air: just perceptible.
2. Light breeze: ship going from one to two knots.
3. Gentle breeze: from two to four.
4. Moderate: four to six.
5. Fresh: when royals can be carried.
6. Strong breeze: first reef and top-gallant sails.
7. Moderate gale: double reefs, topsails.
8. Fresh gales: treble reefed topsails and courses.
9. Strong gale: close reefs.
10. Whole gale: close reefed main-topsail.
11. Storm: storm staysails.
12. Hurricane: no canvass.

WEATHER.

b. Blue sky.
c. Cloudy.
d. Drizzling rain.
f. Foggy.
g. Gloomy weather.
h. Hail.
l. Lightning.
m. Misty.
o. Overcast.
p. Passing showers.
q. Squalls.
r. Rainy.
s. Snow.
t. Thunder.
u. Ugly threatening weather.
v. Visibility of objects.
w. Wet dew.

o under any letter denotes a great degree.

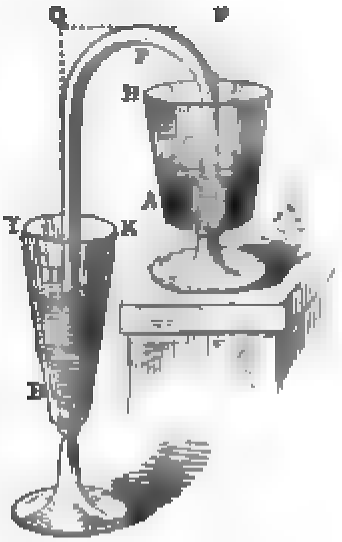
"Cirrus" expresses a cloud, like a lock of hair, consisting of streaks, wisps, and fibres, vulgarly called "mares' tails." "Cumulus," a cloud in dense convex heaps in rounded forms definitely terminated above, indicating saturation in the region of air, and a rising supply of vapour from below. "Stratus" is a continuous extended level sheet, but must not be confounded with the flat base of the Cumulus. "Cumulo-stratus," or anvil-shaped cloud, is said to forerun heavy gales. "Nimbus," a dense cloud spreading out into a crown of "Cirrus" above, and passing beneath into a shower.

SIPHON.

The *Siphon* which is so useful in discharging the contents of one cask into another, in such places as the hold or between decks, where it would be difficult to raise one uppermost, is constructed on the principle of atmospheric pressure.

The tube A F B, is filled with fluid, and the open ends being stopped, it is then inverted, as in the figure, and the ends are opened. In some cases, the tube is placed in the vessel, and the air withdrawn by suction through a small mouth piece on the bent part; upon which the tube becomes filled with fluid. The pressure of the fluid in F A, tending to cause it to flow out of the tube, is equal to the weight of a column A P, reaching from A, to the level of the highest portion of the tube; also the pressure of the external fluid at A, tending to cause it to flow into the tube, is equal to the weight of a column of the height A C, together with that of a superincumbent column of air; hence, the fluid is pressed at A inwards, by the weight of a column of air, diminished by the weight of a column of fluid C P. At B, the fluid is pressed into the tube, by the weight of a column of air, diminished by the weight of a column of fluid D Q. So long then as the column D Q is greater than the column C P, the fluid is pressed into A with greater force than into B, and therefore moves in the direction A F B, until the surface C comes to the level of D.

Fig. 7.



The column will, however, be broken when C P is more than 30 inches in height if the fluid be mercury, and when more than 34 feet in height when the fluid is water. Thus a siphon cannot be made to raise water more than 34 feet, or mercury more than 30 inches; or to raise it at all in a vacuum.*

* Moseley's Mechanics.

CHAP. IV.

CONSTRUCTION.

Ships are built or repaired, according to circumstances, on a Slip, in a floating, or dry, or wet Dock.

Where there is a regular and considerable rise and fall of tide, excavations are made in the land near the water, faced with solid masonry, and mostly having entrances fitted with gates or Caissons, which serve either to retain or exclude the tidal waters as desirable. Those on a larger scale, and which are always kept full of water, are called "wet docks" or basins. These are, in fact, artificial harbours, in which vessels are always kept afloat whilst undergoing internal repairs, loading or unloading, fitting for, or being kept ready for going to sea. Commercial wet docks usually have "locks" (as in a canal) attached to them, so to admit of the entrance and egress of vessels at any time of tide without losing more water than necessary. In Naval wet docks, the ships generally requiring as much water outside as in, one barrier in the form of a caisson is used, and which is seldom worked, excepting at high water.

The Dry Dock is both deeper and narrower. It is deeper, because it is necessary to have more water in the dock at the time of docking a ship than at its entrance. This is for the purpose of gaining depth enough for the Angle Blocks on which the keel of the ship is to rest, and is effected by having the floor of the dock somewhat below the low water mark. Then after closing the entrance, the dock is drained either by pumping, or letting the water run off with the falling tide through channels, called Culverts. It is narrower, because when not water borne, the ship requires to be supported by Shores; which, abutting on the sides of the dock, bear against those of the ship on being set taut by wedging. (*Fig.* 8.)

Formerly, the ship when in dock rested on a row of square blocks of wood, which were kept in their place with ballast. In order to get at her keel for repairing or coppering, &c., it was necessary to lift her bodily off the blocks by numerous shores simultaneously driven up with wedges. This operation not only involved the services of hundreds of mechanics, but the ship

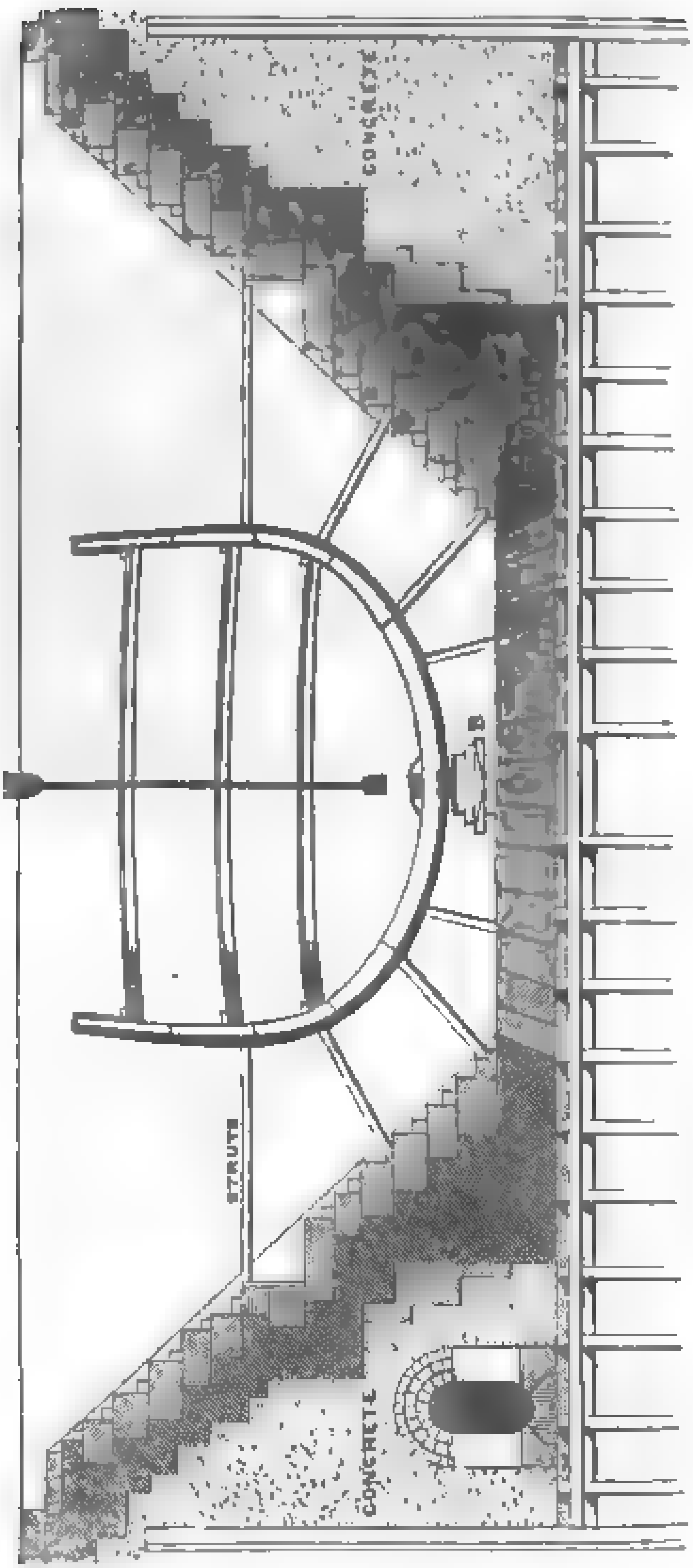


Fig. 8.

became strained at every fastening in consequence of being thus borne in the air. The *Angle Blocks*, which were introduced by Seppings, admit of removal and replacement in succession at such places as require repair; not only with a very few hands, but without the least concussion to the ship.

The *Caisson*, or Floating Dam, is a vessel whose length is equal to the breadth of the dock entrance. Both its ends are formed like the bow of a ship, and the keel is continued up each stem. It is ballasted and fitted with valves or penstocks, and so formed that when full of water and in its place across the entrance, the stem and keel fit accurately into a groove cut in the masonry on the sides and across the bottom of the entrance, the passage of water being thus prevented. When it is necessary to remove the Caisson, the water is either run off at low water or pumped out; and as the entrance is widest at the top, the Caisson on being floated up on the rising water becomes cleared of the grooves and is withdrawn.

One has lately been made for Portsmouth of iron. It is 72 feet long on top, 21 feet wide, 29 feet deep, and 57 feet 7 inches long at the bottom; has 4 pumps and 100 tons of ballast; the weight of hull is 150 tons. These figures may convey a general idea of the weight of iron sea-going vessels.

The *Slip* is an inclined plane formed of solid masonry on the banks of a harbour or river, and carried out some distance beyond the low water mark. Naval Slips have flood gates. The ship's keel is laid on this on blocks, inclining to the horizon at an inclination of $\frac{5}{8}$ of an inch to a foot in her length. As the fabric rises it is supported by Shores; and when the ship is completed, the *Cradle* is placed underneath, and her weight by a process of wedging transferred to it. (*Fig.* 9.) When set close up in its place, this cradle fits like an outside framing of bottom timbers. It is supported by "stopping-pieces," and shores called poppets, resting upon sliding ways which extend along the slip in lines parallel to the keel. These ways are well soaped; all other supports and fastenings are knocked away and the ship glides into the water. The cradle then disengages itself, and the ship is carried into the dry dock for the purpose of having such fastenings as were temporarily cleated on the bottom, for the top of the cradle to bear against, removed, and the process of coppering effected.

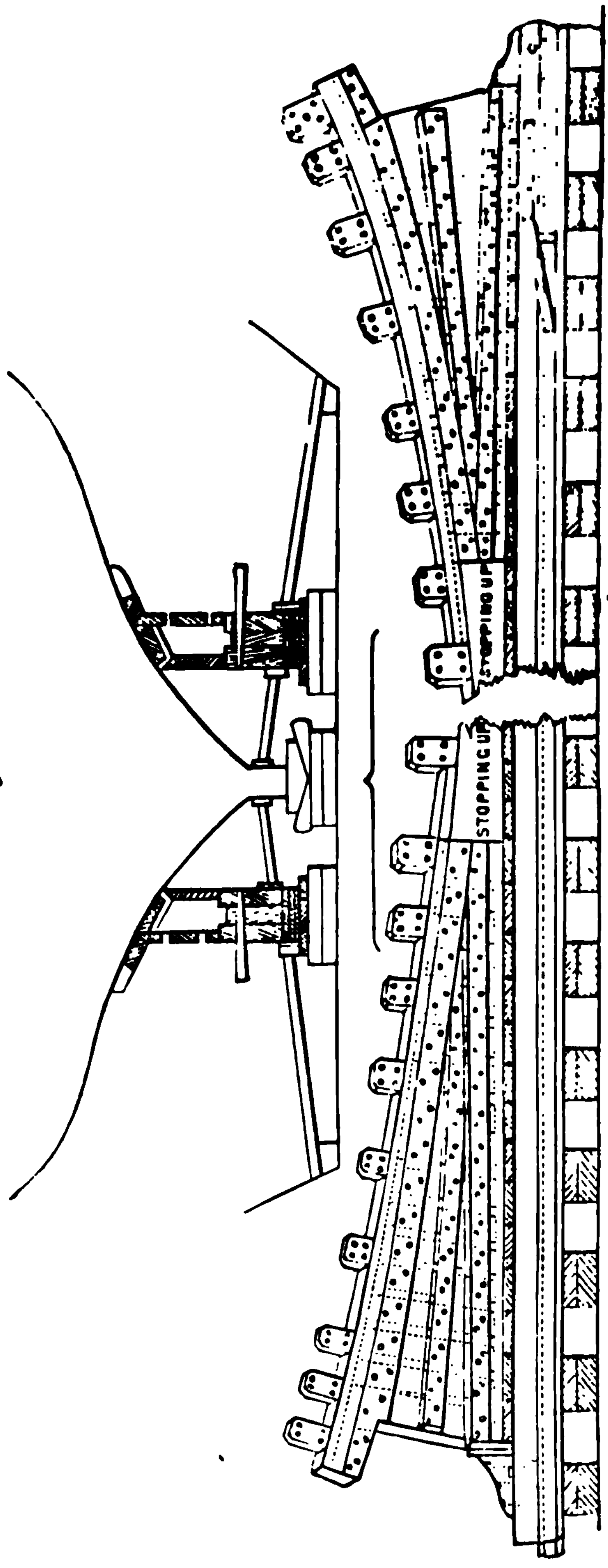


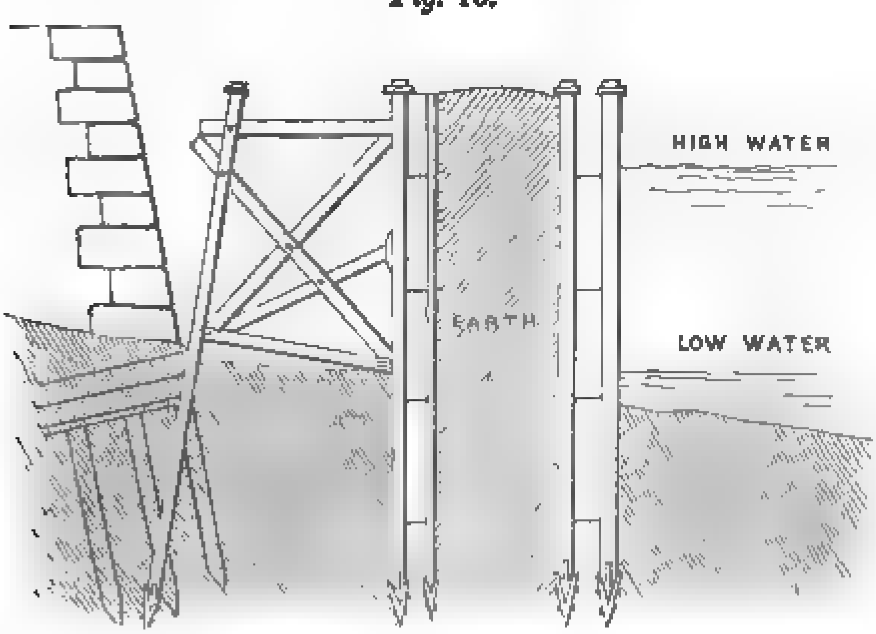
Fig 9.

The *Patent Slip* is an adaptation of the common slip to the purpose of repairing vessels. Carriages in number according to the length of the vessel, fitted with cog-wheels and working on corresponding racks, are run out under the bows of the vessel. When secured upon these she is hauled up either by capstans or steam machinery.

The *Graving Dock*, according to naval distinctions, is open. In it vessels are grounded at high water, for the purpose of receiving trifling repairs on the fall of the tide. Before the introduction of copper sheathing, they were used for the purpose of breaming or cleaning the bottom by fires. In the construction of these docks, serious difficulties and great expenses are incurred. The soil may be so porous that the excavations may be swamped at every high tide, so rocky as to require the severest labour, or so soft that artificial foundations for the masonry have to be formed. They are also subject to the inconvenience of being dependent on tidal action and sufficient depth of water.

In building the sea walls, the foundations are laid dry by means of the *Coffer Dam*, which is an enclosure outside the work

Fig. 10.

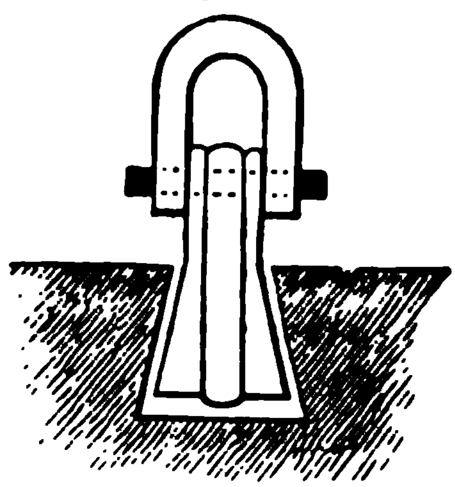


formed by a double row of iron shod piles driven into the bottom so close together as to be nearly water-tight. Clay is rammed in between them, and the water inside pumped out. In 1812 an

artificial foundation for the sea wall at Sheerness was formed by building hollow masses of brick-work 22 feet square on platforms of timber somewhat above the line of floatation. After being floated to the site of the intended wall, they were raised sufficiently high to appear above water at low tide, then filled with shingle, and sunk. Flat-bottomed craft were placed over them at high water, which, as the tide fell, pressed them through the mud. Artificial, as well as natural, stones are used in the construction of marine works. The artificial, either Beton or Concrete, is a mixture of gravel, sand, lime, and water.

In building the new mole at Algiers, Beton was employed in large masses of 20 tons each, formed in cases that became disengaged on lowering them into their places. In what is called random work (*pierre perdue*) the masses are thrown into the water and left to arrange themselves; but in regular building, each block of stone is fitted so accurately as to forbid the use of slings, and is suspended by an iron instrument of a dove tail form, called a Lewis (*fig.* 11.), which is introduced piecemeal into a corresponding hole in the centre of the stone.

Fig. 11.



The margins of rivers or harbours do not always afford facilities for the construction of *slips* or *docks* just in those places where it is desirable to build or repair ships. The ground may be already occupied; the banks may be shallow and marshy; or there may not be a sufficiency of tide. Recourse is then had to a *Floating Dock*, which is a wooden, water-tight, flat-bottomed, box-shaped vessel of sufficient capacity to bear, when afloat, the weight of the vessel, workmen, and materials employed on her. In some cases this float works in an enclosure of masonry, at the bottom of which, when full of water, the float lies. When the vessel is brought over it, the valves are closed, the water is pumped out, and the vessel is carried up on this great stage to a dry level. When the repairs are completed, the valves are opened, the stage sinks, and the vessel floats out.

But, in general, the float is open at the top, and one end is fitted so as to remove or turn down when requisite. Not being

connected with any other structure, it may be moved, whether laden or unladen, to any part of the harbour. On turning the end down, or removing it, the float sinks sufficiently to admit the vessel. On replacing it, and pumping the water out, she remains dry. Where there is "rise and fall," the float is beached at high tide; the water runs off on the ebb; the end is caulked in; and on the next flood the float, being flat-bottomed, is hauled still further up.

Moreover, however valuable for hauling up vessels slips may be, there is always difficulty and strain with large ships. In America, vessels are brought over a sunken hollow raft; on the exhaustion of the water from which, the ship is borne to the surface and lies on a cradle high and dry, with a surrounding platform for the shipwrights to work on. Thus the ship is kept in a horizontal position, without risk of strain, and is always floatable.

A very complete substitute of this kind for the regular dock is Taylor's. It is made of iron, with double sides in compartments. Its entrance is closed by a Caisson, and the pumps are worked by a steam-engine. When the ship is received, and the gate closed, the water is immediately run off to an equal level into the empty compartments, and the remainder pumped out.*

TIMBER.

The Timber chiefly used in the construction of a ship is oak, elm, fir, teak, larch, and mahogany. Timber is purchased by the *load*, a measure which contains 40 feet of rough timber, averaging in weight about one ton. An 80-gun ship consumes as many as 2000 trees, averaging about two tons each.

Timber is divided into three sorts, viz., *square*, which is the full size of the tree, having only its sides squared off; *thick stuff*, which is square timber cut into different thicknesses from 4½ inches to 10, but the whole depth of the tree; and *plank*, which runs from 4 inches down to 1½; all under that size being called *board*.

Deals occur in lengths of 10, 12, and 14 feet, varying in thickness from 3 inches to ½ inch, and averages 9 inches in breadth.

* A very elaborate account of docks of all kinds will be found in a volume recently published by Mr. Stewart of America.

Those which are $\frac{1}{2}$ inch thick, are *flat deals*; $1\frac{1}{4}$ inch are *whole deals.*

Kyanising and *Burnettising* are somewhat similar processes, by which timber, canvass, and cordage are so readily seasoned as to be preserved from the injurious effects of dry rot, mildew, &c., and premature decay.

In the former of these, the article is steeped for a certain length of time in a solution of corrosive sublimate and water. In the latter, as used in Her Majesty's dockyards, canvass and cordage are immersed for 48 hours in a solution of chloride of zinc and water, in a wooden tank, in the proportion of 1 pound of the chloride to 4 of water. Timber is placed in a wrought iron chamber, which contains about 20 loads at once; and after the air is exhausted from both timber and chamber, by means of an air pump which is worked by a steam engine, the solution is forced into the timber by a Bramah's forcing pump, which exerts a pressure upon it equal to 150 pounds on the square inch for eight hours.

"Unless wood is previously well seasoned, to char or paint it accelerates decay by preventing the natural escape of the juices; seasoning requires from two to eight years."*

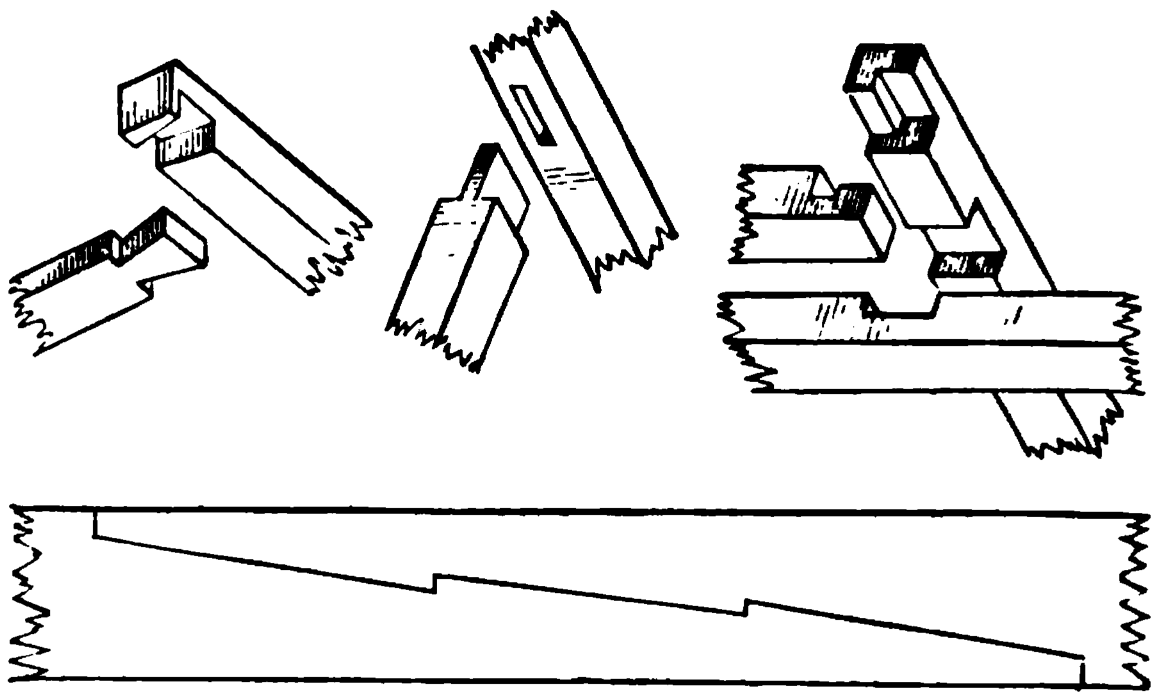
The difficulty and expense involved in procuring suitably curved timber for ship-building purposes, as well as the labour and waste incurred by "*conversion*," seem about to be diminished by timber-bending machines. In these, straight timber, having gone through a process of steaming, is bent into the desired form; not only increasing its value, but economising time, and avoiding that impairment of strength which is consequent on cutting wood against the grain. We are told, for instance, that in one of these machines a piece of straight oak, 14 feet long and 16 inches square, whose value is about 3*l.*, after being bent into the requisite angle is enhanced to three times its value, and that ten such pieces may be thus shaped in as many hours.†

MECHANICAL PROPERTIES OF MATERIALS USED IN CONSTRUCTION.

Timbers are joined together by scarphing, morticing, halving, dovetailing, &c. (*fig.* 12.), and when great strength is required, it is usual to make use of coakings, bolts, and iron bracings.

* Aide Mémoire. † Nautical Magazine.

Fig. 12.



The strength of timber is variable, being affected not only by its place of growth, but degree of seasoning. Trees that have been grown on mountainous districts are stronger than those grown on plains. Roots and trunks are stronger than branches.

The strength of cast iron is not reduced by increase of temperature, provided it be not heated so as to be red hot.

The tensile force of wrought iron is nearly four times as great as that of cast iron.

The tenacity of metal is sometimes increased by hammering or wire drawing; that of copper being nearly doubled. The consolidation is produced chiefly at the surface, and hence a slight notch with a file will materially weaken a hard metallic rod.

The strength of beams is affected by the form of their transverse sections; thus a rectangular beam (submitted to transverse pressure), with its narrow side horizontal, is stronger than with its broad side horizontal in the same proportion as the broad side is wider than the narrow one.

A beam whose transverse section is wedge-shaped, placed with its narrow edge upwards, supported at each end, the strain being on any intermediate point, is stronger than another whose section is equal, but whose form is rectangular. If, however, such beam be supported at only one point, it should be placed with its narrow edge downwards.

An iron bar 4 inches deep, and $\frac{1}{4}$ inch thick, will carry nearly

four times as much as a bar of 1 inch square, though the quantity of material is the same in both cases.

By increasing the distance between the supports of a beam, the strength is proportionately diminished; twice the distance weakens it by one half; half the distance will enable it to bear twice the pressure.

If the pressure be equally distributed over the whole beam, instead of being concentrated at one point, the power of suspension will be twice as great as if it were applied at the middle. Each point of a beam has greater sustaining power the nearer it is to the point of support; so that in loading, less weight should be thrown on the centre than elsewhere. If a beam be twice as *broad* as another, it will be twice as strong; but if it be twice as *deep*, it will be *four* times as strong.

The strength of a beam supported at both ends, is twice as great as that of a single beam of half the length which is fixed at one end; and the strength of the whole beam is again nearly doubled, if both the ends be firmly fixed.*

The following figures are the results of experiments made on the transverse strength of various materials similarly formed.

	Strength of a piece 1 foot long, and 1 inch square.
English oak - - - -	964 pounds.
„ - - - -	436 „
Riga oak - - - -	714 „
Riga fir - - - -	369 „
Dantzic yellow fir - - -	870 „
American pine - - -	658 „
„ white spruce fir - -	570 „
„ red pine - - -	447 „
New England fir or yellow pine -	367 „
Cast iron bar - - -	2691 „

* Mr. Dobson states that the results of experiments made for the purpose of ascertaining the transverse strength of beams may be thus expressed:—

Let s be the weight which would break a beam of given length, and scantling, fixed at one end and loaded at the other; then $2s$ would break the same beam fixed at one end and uniformly loaded; $4s$ would break the same beam supported at each end and loaded in the middle; $6s$ would break the same beam fixed at each end and loaded in the middle; $8s$ would break the same beam supported at each end and uniformly loaded; $12s$ would break the same beam fixed at each end and uniformly loaded.

In the next Table we have the results of experiments made on the transverse strength of cast iron bars, all having the same section, but differently formed.

Description of Cast Iron Bars.	Distance of Supports. ft.	in.	Weight that broke the piece in lbs.	Weight that would break a piece 1 ft. long and 1 in. deep of the same proportions as the specimens.
A bar of 1 inch square - - - - - - -	3	0	897	2691
„ - - - - - - -	2	8	1086	2896
Half the above bar - - - - - - -	1	4	2320	3093
A bar of 1 inch square, the force acting in the direction of the diagonal - - - - - -	2	8	851	802
Half the above bar, do. - - - - - -	1	4	1587	748
Bar of 2 inches deep by ½ inch thick, or the depth to the breadth as 4 to 1 - - -	2	8	2185	728
Half the above bar, do. - - - - - -	1	4	4508	751
Bar of 3 inches deep by ⅓ inch thick; or the depth to the breadth as 9 to 1 - - - - -	2	8	3588	354
Half of the bar do. - - - - - - -	1	4	6854	338
Bar 4 inches, by ¼ inch thick; or the depth to the breadth as 16 to 1 - - - - - -	2	8	3979	166
Edge or angle up - - - - - - -	2	8	1437	1660
„ angle down - - - - - - -	2	8	840	970
Half the first triangular bar, angle up - -	1	4	3059	1770
Half the second triangular bar, angle down -	1	4	1656	960
A feather edged or ⊥ bar, 2 inches deep by 2 wide, with the edge up - - - - -	2	8	3105	1035

Rules for the Transverse Strength.

The last columns in the above tables show the weight that would break a beam or bar 1 foot long and 1 inch square; and as the strengths of rectangular beams are as the breadths multiplied into the square of their depths directly, and is the lengths inversely, we have this proportion: As the weight that will break an inch bar one foot long is to the length of the given beam in feet; so is any given weight to the breadth multiplied into the square of the depth of the beam it would break; and one fourth only of the breaking weight should be the total load on the beam in practice.*

From the following table, the tensile strength and power to

* Nicholson's Practical Carpentering.

resist compression of any of the materials mentioned, may be calculated by simple proportion; that is, as the weight in pounds that would break a piece 1 inch square, is to 1 inch, so is the weight to be supported to the area of the piece in inches which would break by that weight; and four times that area should be the size of the piece used to support such a weight.

Material.		Force in lbs. avoir. per square inch to pull it asunder.	Force in lbs. avoir. per square inch to crush it.
Ash		14·130	9·363
Beech		12·225	9·363
Birch		1·500	5·467
Cedar			5·674
Deal, Christiania		12·346	6·586
„ Norway Spruce		17·600	
„ English		7·000	
Elm	from	9·720	10·331
	to	15·040	
Fir, Memel		9·540	6·499
„ Riga		12·203	
Larch		12·240	
Mahogany		8·041	8·198
Oak	from	10·367	4·684
	to	25·851	9·509
Pine, red		10·038	7·518
Teak	from	12·915	12·101
	to	15·405	
Cast-steel		134·256	
Iron, Swedish malleable		72·064	12 tons.
„ English ditto.		55·872	
Cast-iron horizontal castings		18·656	156·375
Gun metal		36·368	
Wrought copper		33·792	103·040
Brass		17·968	164·864

With a certain limitation as to thinness, the strength of a tube is greater than that of the same quantity of matter made into a solid.

In columns, every piece of timber intended to sustain great

crushing force, should be at least as many inches in thickness as it is feet in length.

"Malleable iron plates are five times stronger than oak; or in other words, their powers of resistance to a force applied to tear them asunder, is as 5 to one; making an iron plate ½ inch thick equal to an oak plank 2½ inches thick."

"The mere dimensions of iron materials are not a sufficient guide, if quality be not also carefully considered. The continued action of passing water, of heat, or of magnetism, have caused curious alterations in the quality of iron, the very particles seeming to have become altered in internal arrangement and form, after the lapse of a few years."

"Steel is used for slide faces, and though so hard, is liable to 'cutting' by steam. It heats and adheres sooner than malleable iron."

Soft metal is a composition of copper 1 pound, tin 50 pounds, and regulus of antimony 5 pounds, valuable for lining stuffing boxes, &c., where there is great heat and friction. When screw propellers were first tried, hard bearings were used; but, becoming heated, and consequently welded to the shaft, were torn out of place. Soft metals have been found to answer better, and lignum vitæ is now preferred to all other materials for this purpose.

"Vulcanised Indian rubber is much used for valves, but requires to be watched and frequently replaced, as it yields and loses shape by degrees. It will evaporate under a very high degree of heat."

Air pumps are lined with gun metal. The rods, buckets, and propellers are also of this material.

All the steam pipes are of copper.

The four following Tables may be found useful as bearing on the weights of several substances used, more or less, in the construction of vessels. The 1st comprises cubic feet and inches, with specific gravity; the 2nd gives the weight of flat bar iron in pounds, and fractional quantities; the 3rd comprises the weight and thickness of different metals; and the 4th gives the corresponding weight and length of iron square and round.

TABLE I., *containing the weight in pounds avoirdupois of a cubic foot; the number of cubic inches in one pound; and also the specific gravities of the substances chiefly used in construction.*

Names of bodies.	Weight of a cubic foot in lbs.	Number of cubic inches in a pound.	Specific gravity.
Copper, cast	549·25	3·146	8·607
Copper, sheet	557·18	3·103	8·785
Brass, cast	524·75	3·293	8·399
Iron, cast	445·43	3·802	7·200
Iron, bar	476·93	3·623	7·600 to 7·800
Lead	709·00	2·437	11·446
Steel, soft	489·56	3·530	7·780
Steel, hard	488·50	3·537	7·840
Zinc, cast	449·37	3·845	7·028
Tin, cast	455·75	3·790	7·291
Bismuth	619·50	2·789	9·810
Gun-metal	549·00	3·147	8·460
Sand	95·00	18·190	1·886
Coal	78·12	22·120	1·240
Brick	125·00	13·824	2·168
Stone, paving	151·00	11·443	2·481
Slate	167·00	10·347	2·888
Marble	171·37	10·083	2·695
White lead	197·50	8·750	6·730
Glass	180·00	9·600	2·453
Tallow	59·06	29·258	
Cork	15·00	115·200	·240
Larch	34·00	50·823	·522
Elm	34·75	49·726	·588
Pine, pitch	41·25	41·890	·660
Beech	43·50	39·724	·792
Teak	46·56	37·113	·657
Ash	47·50	36·370	·845
Mahogany	53·25	32·449	·800
Oak	60·62	28·505	·972
Oil of turpentine	54·37	31·771	
Olive oil	57·18	30·220	·915
Linseed oil	58·25	29·655	
Spirits, proof	57·93	29·288	
Water, distilled	60·50	27·648	1·000
„ sea	64·25	26·894	1·027
Tar	63·43	27·242	
Vinegar	64·12	26·949	
Mercury	848·00	2·057	13·598

TABLE II. — *The weight of one foot of flat bar iron closely hammered, in pounds and hundredth parts.*

Breadth.	Parts of an inch in thickness.								
	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	Inch.
Inches.	lb.	lb.	lb.	lb.	lb	lb.	lb.	lb.	lb.
1	0·21	0·42	0·84	1·26	1·68	2·10	2 52	2·94	3·36
$1\frac{1}{8}$	0·24	0·47	0·94	1·41	1·89	2 36	2·84	3·31	3·78
$1\frac{1}{4}$	0·26	0·52	1·05	1·57	2·10	2·62	3·15	3·67	4·20
$1\frac{3}{8}$	0·29	0·58	1·16	1·73	2·31	2 89	3 47	4·05	4·62
$1\frac{1}{2}$	0·32	0·63	1·26	1·89	2·52	3·15	3·79	4·42	5·04
$1\frac{5}{8}$	0·34	0·68	1·37	2·05	2·73	3·41	4·10	4·78	5·46
$1\frac{3}{4}$	0·37	0·74	1·47	2·21	2·94	3·68	4·41	5·15	5·88
$1\frac{7}{8}$	0·38	0·79	1·58	2·37	3·15	3·94	4·73	5·52	6·30
2	0·42	0·84	1·68	2·52	3·36	4·20	5·04	5·88	6·72
$2\frac{1}{8}$	0·45	0·89	1·79	2·68	3 57	4 46	5·36	6·25	7·14
$2\frac{1}{4}$	0·47	0·94	1·89	2·83	3·78	4·72	5·67	6 61	7·56
$2\frac{3}{8}$	0·50	1·00	2·00	3·00	3·99	4·99	5·99	6·99	7·98
$2\frac{1}{2}$	0·53	1·05	2·10	3·15	4·20	5·25	6·30	7·35	8 40
$2\frac{5}{8}$	0·55	1·10	2·21	3·31	4·41	5·51	6·62	7·72	8·82
$2\frac{3}{4}$	0·58	1·15	2 31	3·46	4·62	5·77	6·93	8·08	9·24
$2\frac{7}{8}$	0·60	1·20	2 41	3·62	4 83	6·09	7·25	8·45	9·66
3	0·63	1·26	2·52	3 78	5 04	6·30	7·56	8·82	10·08
$3\frac{1}{8}$	0·66	1 31	2·63	3·94	5·25	6·56	7·88	9·19	10·50
$3\frac{1}{4}$	0·68	1·36	2·73	4·09	5·46	6 82	8·19	9·55	10·92
$3\frac{3}{8}$	0·71	1·42	2·83	4·25	5·67	7·09	8 51	9·93	11·34
$3\frac{1}{2}$	0·74	1·47	2·94	4·41	5·88	7 35	8·82	10·29	11·76
$3\frac{5}{8}$	0·76	1·52	3·05	4·57	6·09	7·61	9·14	10·66	12·18
$3\frac{3}{4}$	0·79	1·58	3 15	4·73	6·30	7·88	9·45	11·03	12·60
$3\frac{7}{8}$	0·82	1·63	3·26	4·89	6·51	8·14	9·77	11·40	13·02
4	0·48	1·68	3·33	5·04	6·72	8·40	10·08	11·76	13·44

TABLE III. —*The weight of a foot superficial of wrought and cast iron, &c. according to the above thickness.*

Wrought Iron -	2·52	5·04	10·08	15·12	20·16	25·20	30·24	35·28	40·32
Cast Iron	2·35	4·69	9·37	14·06	18·75	23 44	26·12	32·81	37·50
Brass -	2·84	5·68	11·35	17 03	22 70	28·38	34·05	39·72	45·40
Copper	2·89	5 78	11·56	17·34	23·12	28·90	34·68	40·46	46·24
Lead, cast	3·70	7 39	14·78	22·17	29·56	36·95	44·34	51·73	59·12

Example. To find the weight of a bar of iron 4 feet long, 2 inches wide, and $\frac{3}{4}$ inch thick, by the above table: 1 foot weighs 5·04 pounds, which, if multiplied by 4 (the length), will give 20·16 pounds, or $20\frac{16}{100}$ pounds, the weight.

TABLE IV., *showing the weight of square and round iron of one foot in length.*

Square Iron.			Round Iron.		
Wrought.		Cast.	Wrought.		Cast
Scantling. Inches.	Pounds.	Pounds.	Diameter. Inch.	Pounds.	Pounds.
¼	0·21	0·20	¼	0·16	0·15
⅜	0·47	0·46	⅜	0·37	0·34
½	0·84	0·78	½	0·66	0·61
⅝	1·31	1·22	⅝	1·03	0·96
¾	1·89	1·75	¾	1·48	1·38
⅞	2·57	2·39	⅞	2·02	1·88
Inch.	3·36	3·12	Inch.	2·64	2·45
1⅛	4·25	3·95	1⅛	3·34	3·10
1¼	5·25	4·88	1¼	4·12	3·85
1⅜	6·35	5·90	1⅜	5·00	4·64
1½	7·56	7·03	1½	5·94	5·52
1⅝	8·87	8·25	1⅝	6·97	6·49
1¾	10·29	9·57	1¾	8·08	7·52
1⅞	11·81	10·98	1⅞	9·28	8·62
2	13·44	12·50	2	10·55	9·71
2⅛	15·17	14·11	2⅛	11·92	11·08
2¼	17·01	15·80	2¼	13·37	12·40
2⅜	18·95	17·02	2⅜	14·87	13·84
2½	21·00	19·53	2½	16·50	15·34
2⅝	23·15	21·53	2⅝	18·20	16·91
2¾	25·41	23·63	2¾	19·97	17·56
2⅞	27·77	25·83	2⅞	21·81	20·29
3	30·24	28·12	3	23·75	22·09
3¼	35·49	33·00	3¼	27·88	25·92
3½	41·16	38·28	3½	32·34	30·06
3¾	47·25	43·94	3¾	37·12	34·52
4	53·76	50·00	4	42·22	39·27
4¼	60·69	56·44	4¼	47·66	44·33
4½	68·04	63·28	4½	53·44	49·60
4¾	75·81	70·50	4¾	59·54	53·37
5	84·00	78·12	5	65·98	61·36
5¼	92·61	86·13	5½	79·82	74·19
5½	101·64	94·53	6	95·00	88·35
5¾	111·09	103·32	6½	111·54	103·70
6	120·96	112·50	7	129·30	120·26
12	483·84	450·00	12	380·00	353·42

1 foot cube of wrought iron will weigh (average) 475 pounds.
„ close hammered - - - - 480 to 490 „
„ cast iron (average) - - - - 450 „

Bolts occur in great variety; their sizes are denoted by their diameter, and their particular dimensions are determined by the tension to which they are meant to be exposed; generally speaking, that should not exceed one fifth of their tabulated strength. They are made both of iron, copper, and a composition of copper and zinc. The bolts are formed like the letter T. Saucer-headed are flat, and collar-headed are thicker for the head. When bolts have to resist great strain in the direction of their length, their points are riveted, clenched, or fore-locked over a ring, or washer. In other cases, their points are merely jagged, being then rag-bolts, which are easily drawn out by a direct strain. Eye bolts have an eye formed in one end, and are driven, when possible, edgeways to the strain they have to bear. When the strain which they are intended to resist is unusually great, they are formed with a shoulder, and are driven through an iron plate with that projection in the direction of the strain.

The adhesive force of nails or bolts is greater when driven across the grain, than with it; thus, a sixpenny nail, 73 to the pound, 2½ inches long, driven into dry elm to the depth of 1 inch across the grain, requires a force of 327 pounds to extract it; whereas, driven with the grain, it may be extracted by a force of 257 pounds. The same nail, driven 2 inches into dry oak, requires a steady force of more than half a ton to extract it.

Screws 2 inches in length, ·22 diameter at the exterior of the threads, ·15 diameter at the bottom, ·305 depth of thread, and having twelve threads in an inch, have been passed through different pieces of wood, each of which was ½ inch thick, and drawn out from the following woods by the annexed weights:—Beech, 460 pounds; another specimen, 790 pounds; ash, 790 pounds; oak, 760 pounds; mahogany, 770 pounds; elm, 655 pounds. The force required to draw similar screws out of deal and the softer woods was about half the above.

The following table exhibits the relative adhesion of nails of various kinds when forced into dry deal at right angles to the grain of the wood.*

* Experiments by Mr. Bevan.

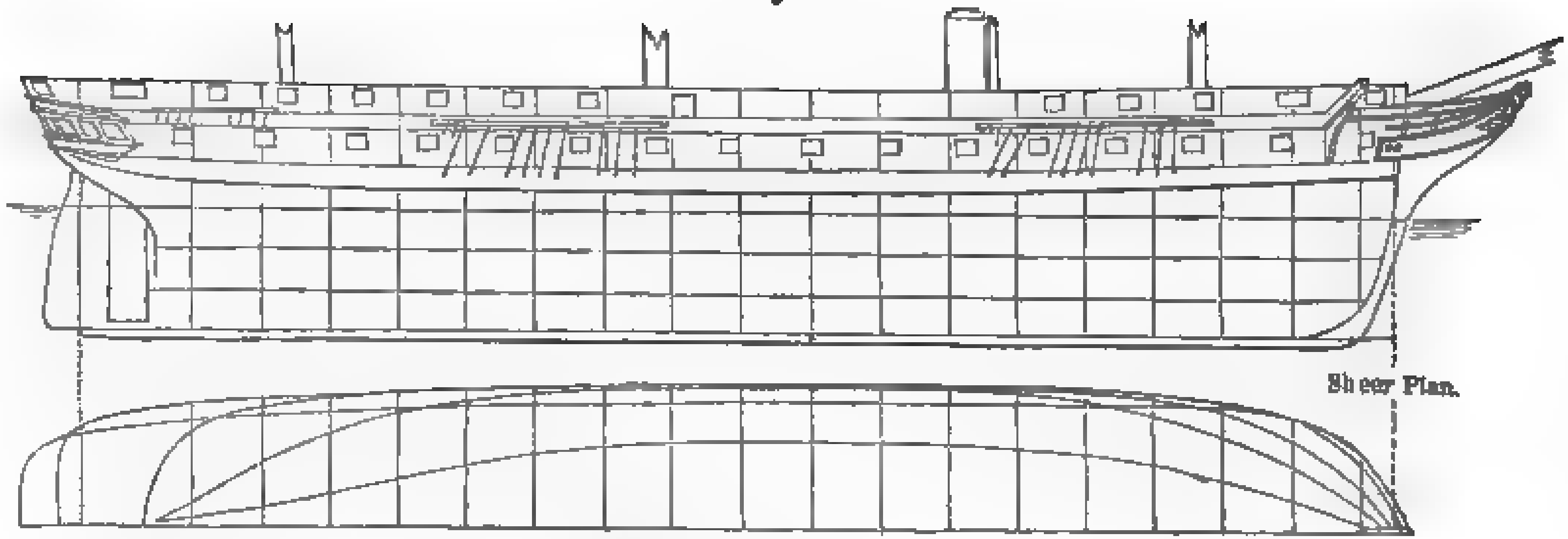
Description of nails used.	Number to the lb. avoir.	Inches long.	Forced inches into the wood.	Pounds requisite to extract.
Fine Sprigs - -	4560	0·44	0·40	22
Ditto - -	3200	0·53	0·44	37
Threepenny brads -	618	1·25	0·50	58
Cast-iron nails -	380	1·00	0·50	72
Sixpenny nails -	73	2·50	1·00	187
Ditto - -	...	...	1·50	327
Ditto - -	...	...	2·00	530
Fivepenny nails -	139	2·00	1·50	320

A sixpenny nail driven into dry elm to the depth of 1 inch across the grain, required a pressure of 327 pounds to extract; and the same nail, driven endways, or longitudinally into the same wood, was extracted with a force of 257 pounds. The same nail driven 2 inches endways into dry deal, was drawn by a force of 257 pounds; and to draw out one inch, under like circumstances, took 87 pounds only. The relative adhesion, therefore, in the same wood when driven transversely and longitudinally, is 100 to 78, or about 4 to 3 in dry elm; and 100 to 46, or about 2 to 1 in deal; and in like circumstances, the relative adhesion to elm and deal is as 2 or 3 to 1. In other species of wood, the requisite force to extract the nail was different: thus, to extract a common sixpenny nail from a depth of 1 inch out of dry oak, required 507 pounds; dry beech, 667 pounds; green sycamore, 312 pounds; so that it would require a force of about half a ton to extract a sixpenny nail which was driven two inches into dry oak. A common screw of ¼ inch was found to have an adhesive force of about three times that of a sixpenny nail.

In the Mould Loft are to be found the drawings of the vessel which the designer purposes to build. By these, the form and dimensions of every particular piece of wood that is to enter into the structure, are determined.

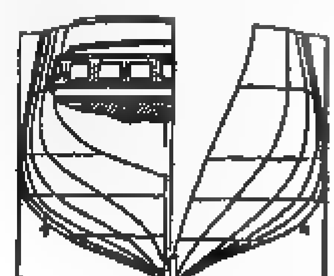
The principal one is the Sheer Drawing. It represents the vessel in her length, breadth, and depth; and is composed of three plans; viz., the *sheer plan*, which is a vertical section, passing through the vessel in its whole length, fore and aft, dividing it into two equal

Fig. 18.



PRINCIPAL DIMENSIONS.

Length between the Perpendiculars	214 2
" of the keel for Tonnage	180 8[illegible]
Breadth extreme	60 0
" for Tonnage	49 6
" moulded	48 8
Depth in Hold	16 9
Burthen in Tons	2235[illegible]



Body Plan.

parts. On this plan (*fig.* 13.) are represented the length and depth of the keel, the rake and height of the stem and stern-posts, the position of the frames, water-lines, decks, ports, masts, channels, rudder, screw aperture, &c. The *half-breadth plan* contains the several half-breadths at every frame of timbers at the different heights of the water lines, main breadth, top sides, riband lines, &c. The *body plan* represents transverse, or athwart ships sections of the ship, perpendicular to the keel. The several breadths and particular form of every frame of timbers are described on this. In the body plan, the half-breadths of the fore body are shown on the right, and those of the after body on the left of the middle line.

From these drawings, the form of the ship is "laid off" in full size on the floor of the mould loft. Moulds of thin fir boardings are then formed, and by these the timbers are worked into shape.

The *Keel* is made of elm in pieces, scarphed and coaked together.

The *Stem* is connected with the fore end of the keel by a knee, and is strengthened on its after side by the *apron* and *stemson.*

The *Knight-heads* rise from the apron on each side of the *stem.*

The *Stern-post* is connected with the after end of the keel by tenons and plates of metal; it is strengthened on its fore side by the inner stern post, and its after side is fitted with braces for the rudder.

The *Deadwood* are chocks of timbers fastened along the upper side of the keel, which form a seating for the floor timbers, and which are shaped into the form in the fore and after parts of the ship. In vessels intended for the screw, an aperture is cut in the after part of the after deadwood, and an additional stern post called the Body Post introduced at the fore part of the cutting. Where the run is abrupt, the fore part of this aperture intrudes upon the body of the ship, and the flat surface is planked in athwart ships.

The *Keelson* lies fore and aft on top of the keel, deadwood, and floors, and being bolted through all, unites these timbers in one mass.

The *Floors* are timbers extending on each side of the keel to about a quarter of the breadth of the ship.

A *Frame of timbers* is composed of the floor timber, two or

Fig. 14.

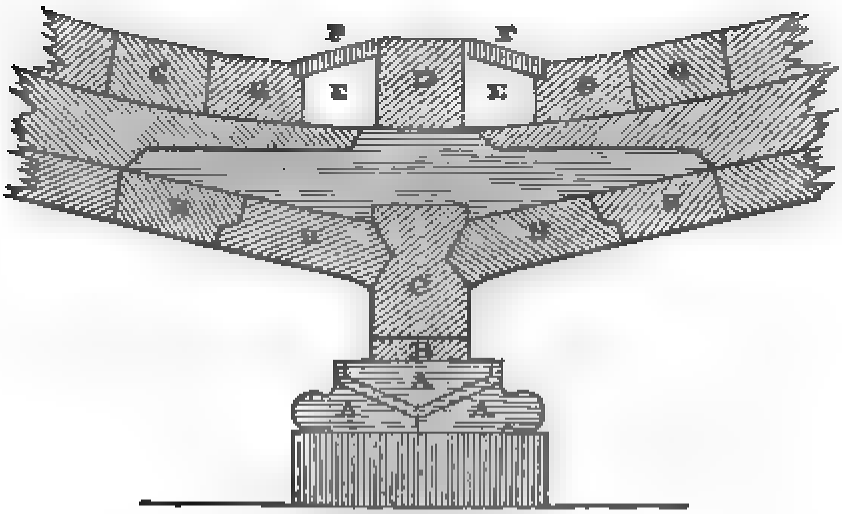


Fig. 14. A are the angle blocks, B false keel, C main keel, D keelson, E limbers, F limber plates, G limber strakes, H Garboard strakes.

more futtocks, and a top-timber on each side; that which encloses the greatest space is called the *Main frame.* The frames give the form to the vessel athwart ships, are put together on the ground, their ends being connected by coaks, and then placed across the deadwood.

The *Beams* serve to support the decks, as well as to connect and preserve the sides at their proper distance apart; their ends are secured above, by the water ways, beneath by the shelf piece, and also by iron braces, or knees.

These are the principal timbers which compose the skeleton of the ship. The sides are connected with the stem and stern posts by iron fastenings called Breast hooks and crutches; and the whole fabric is further united by iron bands called riders, which run diagonally along the inside of the frame timbers. This additional strengthening is known as *trussing,* and acts against the inclination which the extremities have to droop, or hog.

The *Side Keelsons* are short internal keels, which are laid about six feet on each side of the keelson. Their use is to divide with the floor timbers, the strain caused by the heel of the main mast in its step.

In steam ships there are no side keelsons, but similar timber-sleepers are placed in the same position, which, extending along the bottom the whole length of the engine-room, form a platform for the engine.

Fig. 15.

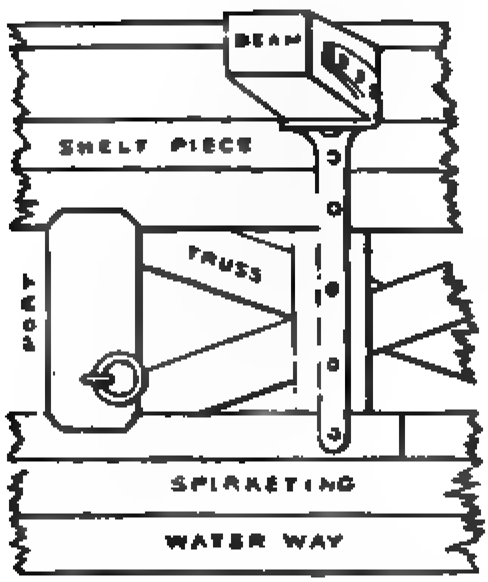


Fig. 16.

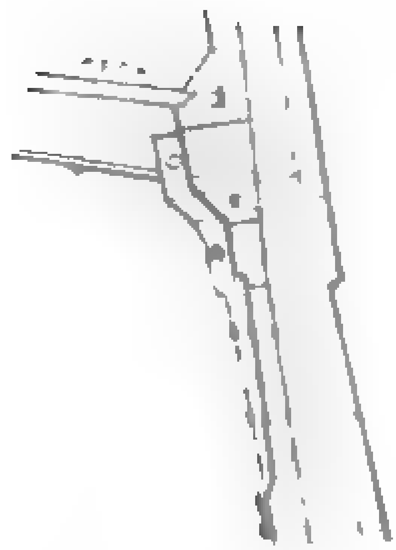


Fig. 16. 1 is the water way, 2 the shelf piece, 3 iron brace.

The *Steps* for the fore and main masts, are fastened across the keelson; that of the mizen masts being usually fixed on the lower deck beams.

The *False Keel* is an additional keel from 4 to 6 inches thick, fastened on below the main keel.

The *Gripe* is a projection at the fore lower part of the stem. Both these two last named fitments are meant to serve to prevent lee way, and protect the adjoining timbers, when the ship strikes the ground.

The *Limbers* are spaces left vacant between the limber strakes and the keelson, forming passages for water to the pump well. These are covered by solid iron plates which, resting on the edges of the keelson and limber strakes, exclude such matter as would be injurious to the pump valves. These plates, moreover, represent so much ballast.

The *Planking* is the internal, as well as the external skin of the ship. That which is outside is usually laid on in strakes placed "anchor-stock fashion," which is considered the strongest mode of arranging these layers. At that part near the water line, called the bends, they are of oak; and near the keel, called the garboard strakes, are of elm. This planking is fastened by trenails, large wooden bolts which, passing through and through, secure both these coverings of the inner planking: the principal

are the *ceilings* in the holds; the *sperketing*, which run above the water ways; the *clamps* which run under the shelf pieces; and the *limber strakes*, which lie nearest the keelson.

The *Channels* are strong platforms on the sides, abreast the masts, for the purpose of giving greater spread to the rigging. The binding of the dead eyes are let into the outer edges, and secured there by the *channel rail*, and an eye bolt is driven in on each side of the dead eyes for the lanyards of the rigging.

The *Bill Boards* are iron shod stools just before and abaft the fore channels, on which the flukes of the anchors are stowed.

The *Cat Head* is a timber projecting on the top of the round of each bow, by which the anchor is stowed. It is pierced with sheaves, and fitted with eye bolts, thumb cleats, and slip.

The *Head Knees* project beyond the upper part of the stem, supporting the figure head, and are pierced inside with holes for the gammoning; and outside for the bobstays.

The *Decks* are laid both fore and aft, as well as diagonally. The spaces left open for hatch and ladder ways are edged with timbers, those fore and aft being called Coamings, those athwart ship's head Ledges, those which surround the mast and capstan holes being called Partners. The decks are fastened by nails, called dumps, driven, as all iron nails in ship building are, with a twist of tarred oakum round the head. The holes for the cables are strengthened by chocks, lined with iron, and are called the trunks.

The *Riding Bitts* go through the decks, and are supported on their fore side by knees, which are let down to the deck beams. When there is a cross piece, it is hooked on the after side. All ships of 28 guns and upwards have two pairs; those which have no cross piece, have moveable iron horns, called battledores, projecting from the outside, which serve to keep the cables up in their place. The bitts, as well as the hawse holes, are shod with iron, and as this causes a severe *nip* to cables when riding out a gale, great care is taken to keep the cable shackles clear of both, as well as by veering a little occasionally (freshening the nip), to keep the chafe off any one particular part of the cable.

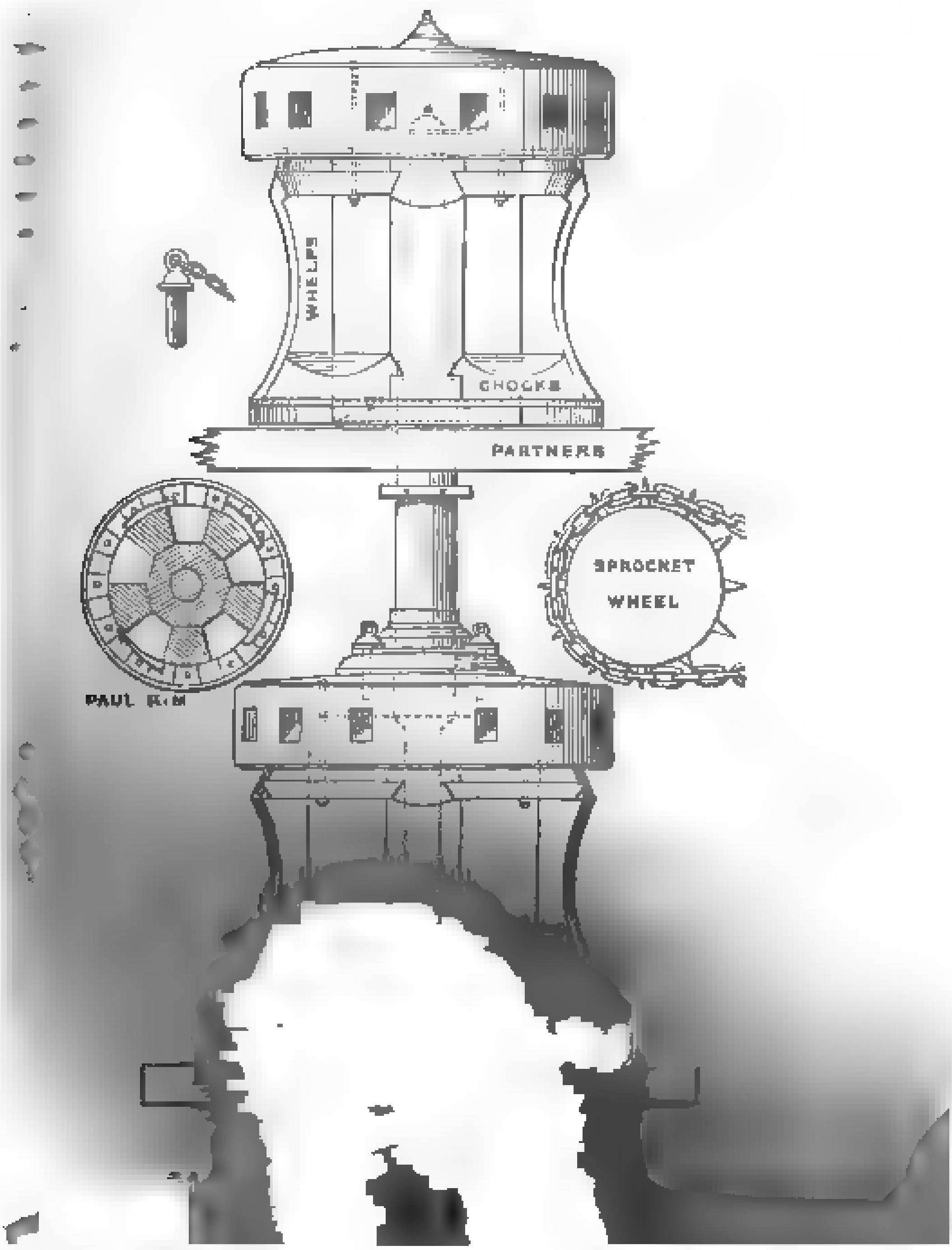
Steam ships have after bitts for towing purposes in addition.

The *Ports' Sides* are formed by the timbers of the frame, and their upper and lower parts by timbers, called Sills. The port lids are made of fir of two thicknesses, placed opposite ways.

is pierced for a scuttle, which serves for ventilation, and also g room for the rammer staff, when the guns are being ed in such sea-way as necessitates the closing of the ports t loading. Port lids are secured by a wooden bar across inside of the port. Through this two iron hooks project; hook on to ring bolts in the lid, and are drawn in by iron ges, and are "triced up" by a tackle and chainspan.

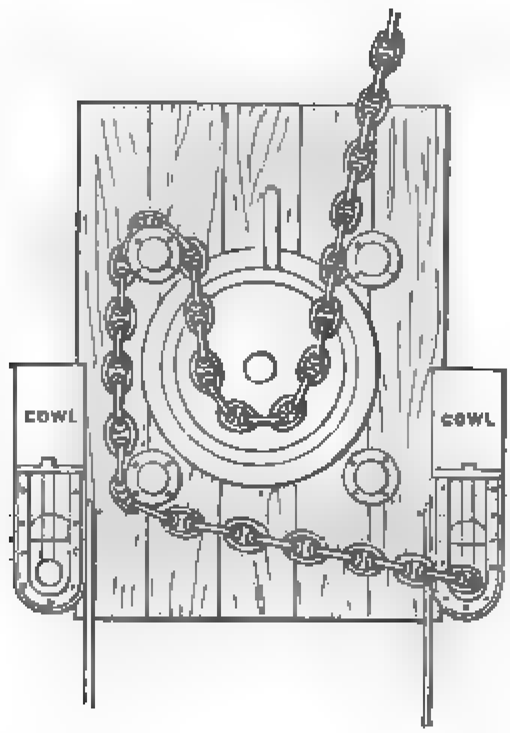
he *Spindle of the capstan* reeves through a metal bushed hole

Fig. 17.



in the partners, pivoting in a socket on the deck below. The upper part passes through the main piece, the barrel, on the sides of which stand the Whelps; these derive mutual support from chocks that are let in at top and bottom. The top piece,

Fig. 18.



the *Drum Head*, is strengthened by metal bands, and is pierced with holes for the bars, pins, and drop bolts. The lower part of the whelps are enclosed by a metal band, on which the pauls are bolted; and a corresponding circular plate, the paul rim, having cogs, is let into the partners, which, when the pauls are down in the proper direction, serve to secure the capstan from moving.

When ships have a double capstan, the point of the upper spindle is secured to a plate, which is received on another one on the head of the lower capstan. These plates have corresponding holes; and when it is desirable to connect both capstans, the drop bolts are entered. (*Fig.* 17.)

Capstans fitted for chain messengers are made with a *Sprocket Wheel*, the teeth of which enter the messenger links.

In some cases the cable itself is taken partly round the ...n, the links either binding in corresponding indentations

made on a metal casting, or else working on a sprocket wheel, the cable being carried to its own side round a friction roller. (*Fig.* 18.)

When double capstans are supplied, the lower one only is made to receive the chain messenger or cable. They are usually worked in connection, as the upper deck affords most space for the crews; but the lower capstan is seldom manned unless much additional force is required.

Number and length of bars :—

	No.	Length. Feet.
18 guns	10	9·0
28 "	10	10·0
36 "	12	11·6
74 "	14	12·6
80 "	14	13·0
100 "	14	13·6
120 "	14	14·0

The *Compressors* are arrangements for controlling the cables; those mostly used are iron levers placed under the beams over the cable lockers, and worked by tackles.

Scuppers are usually placed up and down; but when given a little rake aft, they discharge equally well, and do not admit water so easily when the ship is rolling. The lee side of a lower deck may be kept dry by boring the scupper plugs out and fitting a leather valve at the small end. The *Bow Scuppers* will be always out of repair and admit water, unless let well into the wood and made to stand upright.

The *Hawse Bucklers* are wooden blocks, which, after the plugs are driven in, close up the hawse holes inside. Those in one piece are called blind bucklers. They are secured in their place by iron bars.

The *Hold* is divided into the different compartments by strong oak bulk-headings or partitions, the planks of which are tongued at the joinings of the edges with strips of iron. Those of the magazine are treble, and formed diagonally, each layer running in opposite directions, having felt and mortar between them. The top or crown is covered with thick planking, and also protected with mortar.

The *Magazines* are entered through inner and outer handing-

rooms, the doors of which are perforated with holes sufficiently large for the passage of cartridge-boxes; and both these rooms, as well as the magazine itself, are lighted by lanterns placed in separate adjoining chambers called light rooms.

The air necessary for the consumption of lights and people employed in the supply of powder, is supplied from the limbers.

The *Engine Room* partitions are of iron. A bulk-head of that metal running fore and aft on each side, leaving a space between itself and the ship's side, forms the coal bunkers. By this arrangement the machinery is protected from injuries by horizontal fire from an enemy. The bunkers are filled from the deck overhead, and are discharged through openings into the stoke-hole. As one or other of these apertures is always open, no danger can arise from such explosions as occur where coal has been so closed in as to confine the hydrogen gas which invariably generates, and which ignites on the approach of flame. Several colliers have very recently been seriously injured by neglect of this consequence; and where coal has been stowed in large tanks, made on purpose for its reception, explosions have not been unfrequent. So that in the stowage of coal, its chemical properties must be considered, or else they will force themselves on our notice.

In *Caulking*, the seams are driven open, reamed, and oakum in proportion to the thickness of the planking driven in. They are then covered and payed with pitch or marine glue. The planking in the holds, called the lining, is only chintzed, *i. e.* the oakum is neither hardened in nor payed.

COPPERING.

Many remedies have been applied to preserve the ship's bottom from the ravages of marine animals, and from the adherence of marine vegetables. Lead and wooden sheathing obtained until the introduction of copper in 1761. In *Sheathing*, the wood was closely studded with nails, and then overlaid with pitch, a process which was called graving. In *Coppering*, the sheets are fastened on with composition nails; the sheets, being 4 feet long and 14 inches wide, are placed lengthways with the sheer of the ship. Their lower edges overlap the upper ones of those below, and their after ones the foremost of those abaft

them. This metallic skin fits so accurately as to wrinkle or become rent when the ship has been strained, and thus denotes injury done to the fabric.

Copper sheets are described as 32 ounces, 28 ounces, 18 ounces, 16 ounces the superficial foot. The thickest are used near the bows and water line.

The *Figures* on the sides of the stem and rudder mark the ship's draught of water. They are each 6 inches long: the lower part shows the feet, and the upper the inches.

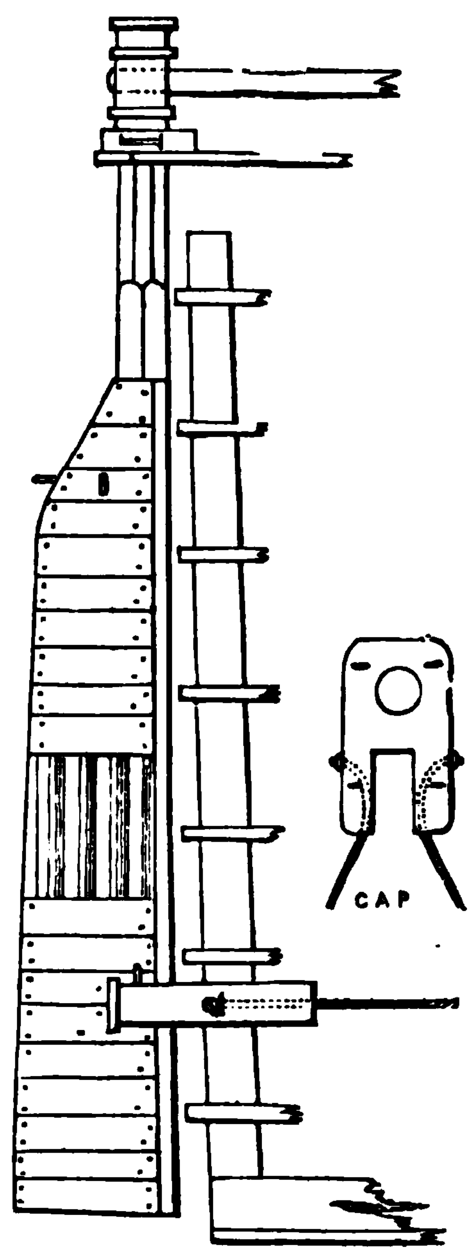
The main piece of the *Rudder* is oak, with an elm edging on the fore part; the after parts, fir. Its head is circular and iron hooped, and the holes for the tiller and for the key for the spare tiller, are iron plated: the heel is covered by a sole piece. The fore side of the rudder and after side of the stern-post are cut away (bearded) sufficiently to permit the rudder being moved to an angle of 42° from a fore and aft line, which in steering is considered the extreme point of efficiency. There is a strong metal strap on the after part near the water line to which the rudder chains are fastened. As it is with tackles from the quarters to these chains that the ship is steered when the rudder-head is carried away, this strap should be well bolted through.

In steam ships, where the position of the screw aperture interferes with the use of the usual tiller, a yoke is frequently used, and the rudder-head fitted accordingly.

The head is hoisted up through the "helm port:" the pintles enter the gudgeons, and the rudder is thus "hung."

The *Rudder Chocks* are blocks of wood, which are forced in along-side the head to keep it steady when

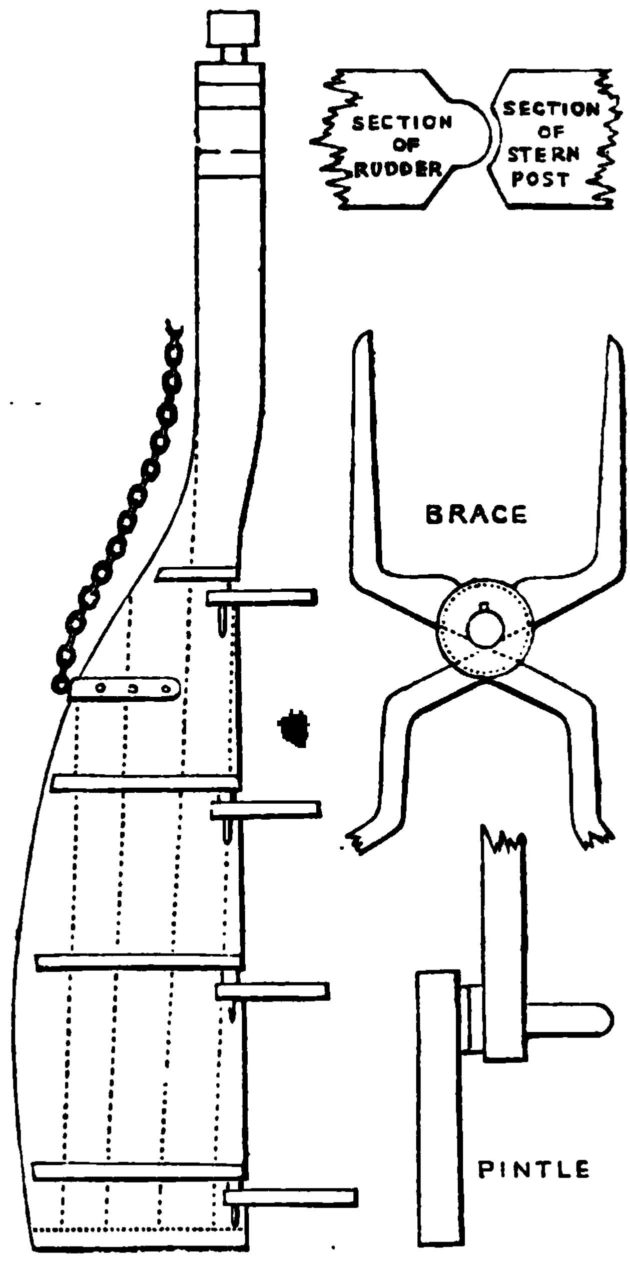
Fig. 19.



Jury rudder made with a top-mast and top-mast cap.

desirable, as well as to prevent the rudder from being easily
shipped on touching the ground: a piece of wood, called
Woodlock, is nailed on the foreside between the upper pintl
Rudders are usually one twenty-eighth part the length c
ship.

Fig 20.

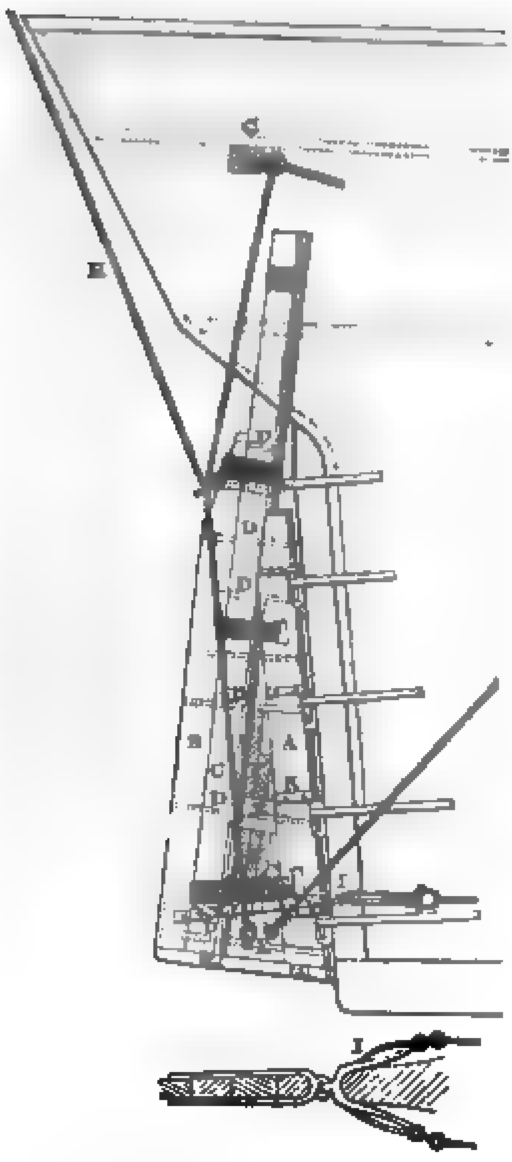


New Pattern Rudder.

All ships are supplied with materials with which a temp
rudder may be made when necessary. (See *fig.* 21.)

The *Figure Head*, which probably owes its existence to ar
superstition, which supposed that the image of some sai
hero conferred safety or success on the ship to which it
attached, is part of a vessel rather decorative than useful, e
as serving to denote the ship. In other days of naval wa
it sometimes performed good service, being a formidable we

Fig. 21.



Sketch of a temporary Rudder.

Per Admiralty Order of the 28th January, 1830.

A. A piece of fir, sided one third less than post, fitted with iron pintles while in dock, and supplied to each ship.
B. A piece for the back, either provided or taken from the ship's stores.
C. Spare top-mast, cut off clear of the shiver hole.
D. Iron Bolts. E. Chocks. F. Iron pig ballast.
G. Screw eye bolt, in quarter-deck beam, to be put in when required.
H. Rope guys (through the heel chock E), to facilitate the hanging of the rudder.
I. Gudgeon brace fitted to the stern-post while in dock, and supplied to the ship.
K. Lower pintle to be four inches longer than the others.

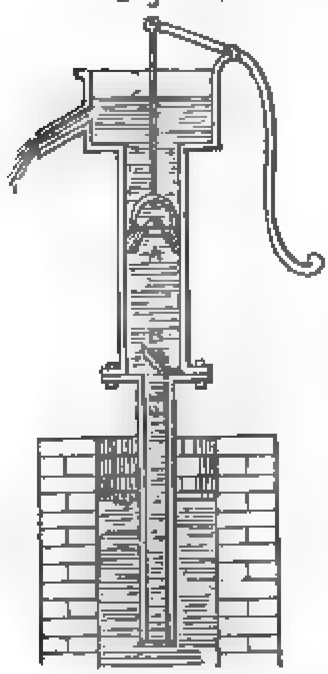
In ships having a screw aperture, it would be necessary to cross the guys underneath the after bearing.

when propelled with force against an antagonist. When well conceived and executed, it adds considerably to the beauty of a vessel, and might even be turned to moral account in the time of action; for few British seamen would be reluctant to follow where even the image of his Sovereign, or Nelson, or Wellington, or Collingwood led the way.*

PUMPS.

The common *Pump*, such as the wash-deck one, is constructed with reference to atmospheric pressure, which, in ordinary conditions will force water into a vacuum to the height of 32 feet. It is a pipe open at each end, having a moveable air-tight piston, in which is a valve. There is also a fixed valve about 30 feet from the lower end: both these valves opening upwards only.

Fig. 22.

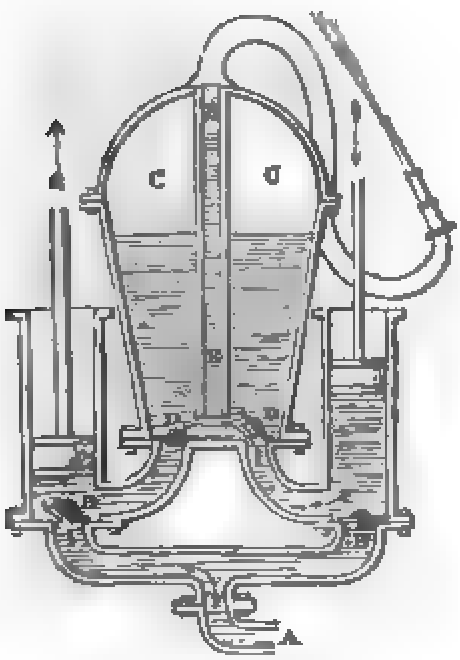


On working the piston that part of the tube which is below it becomes exhausted of air; the atmospheric pressure on the external surface of the well forces the water up through the lower valve to supply the vacuum, and fills all the space between the valves with water. On the descent of the piston, the water rises through the upper valve, and is on the ascent of the piston discharged from the spout of the pump. Thus every time the piston is raised, the upper valve closes and the lower one opens; and every time it descends, the upper one opens and the lower one closes. Although the lower valve must never be more than about 30 feet from the surface of the water, yet when the water has passed through the upper valve, it may be lifted to any height, provided the tube and piston rod be sufficiently long. (*Fig.* 22.)

* Drawings of figure heads will be found in great variety in that handsomely illustrated old work, Charnock's "History of Marine Architecture." For much useful information on the subject of ship-building, we refer our readers to "Fincham's Outlines," a Work from which we have, with the author's kind permission, made several selections.

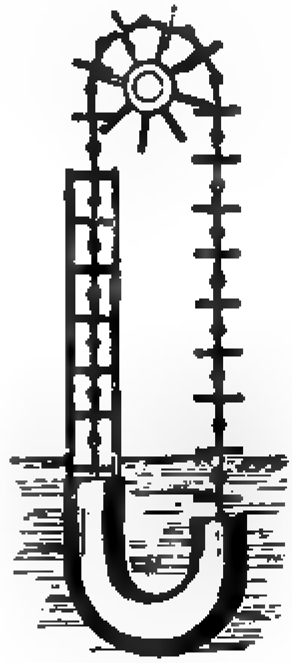
The *Fire Engine* is a double forcing pump; and a continuous flow of water is obtained by attaching an air chamber C. Th pistons are solid, having no valves; and their motion is alternate. In their ascents, a vacuum is formed in each cylinder which is immediately occupied by water from the suction pipe A, and their descents force that water into the air chamber, from whence it is driven by the compressed air through the discharge pipe. (*Fig.* 23.)

Fig. 23.



Fire Engine.

Fig. 24.



Chain Pump.

The *Chain Pump* (*fig.* 24.) is an endless chain passing over a skeleton roller, or sprocket-wheel, on deck, and through a curved metal tube in the hold or pump well. A series of circular leather-edged plates are fixed about 18 inches apart on this chain, and which stand at right angles with it. Both parts of this chain are contained in separate cases; on turning the upper wheel, which is done by means of winches, the water is carried up between each of the ascending plates, and is discharged overboard through the *Pump Dale.*

These pumps cannot be made available in the event of the ship being considerably inclined. In the case of the " Samarang," when on shore, "it was found that the inclination caused the

slack part of the chain to fall into a curve, and the descending discs to overlap the trunks so much as to render them useless." * In the "Algiers," nozzles were fitted on the metal dales, on the orlop decks, and thus when water was required in the lower part of the ship for the extinction of fire, the hoses were connected without interference with any of the gun-deck arrangements, or injury to the hoses themselves.

Massie's Pump is a double action lift and forcing pump, and has, in discharging as much as eleven tons in nine minutes, claimed a superiority to others.

Steam ships are fitted with *Bilge Pumps*, which are worked by the engine in extraordinary cases of leakage: and also with hand pumps, for the purpose of feeding the boilers, when the engines are not at work. These latter are turned when desirable to such purposes as washing decks, &c, and are capable of connection with the engine.

The pumps and main mast are all enclosed from the bottom of the ship as far as the orlop deck.

The quantity of water discharged by a hand pump in a given time, is determined by considering that at each stroke of the piston, a quantity is discharged equal to a cylinder whose base is the area of a cross section of the body of the pump, and height the play of the piston ; thus, if the diameter be 4 inches, and the play 3 feet, we have to find the content of a cylinder 4 inches in diameter and 3 feet high. Now 4 inches is the $\frac{1}{3}$ of a foot, or ·333, hence, $·333 \times ·7854 = ·110999 \times ·7854 = ·08796$ = the area in square feet; hence, $·08796 \times 3 = ·2639 =$ the content of the cylinder in cubic feet = the quantity of water discharged by one stroke. A cubic foot of water weighs about 63·5 pounds; therefore, $·2639 \times 63·5 = 16·756$ avoirdupois; and an imperial gallon is equal to ten pounds of water; whence dividing 16·756 by 10, we get the number of alc gallons $= 1·6756$.

The resistance is equal to the weight of a column, whose base is the area of the piston, and whose height is that of the surface of the water in the body of the pump above the surface of the water in the well, together with friction.

Let the body of the pump be 6 inches in diameter, and the height to which the water is raised be 30 feet, the weight of the

* Treatise on Surveying.

piston and rod 10 pounds, and the friction $\frac{1}{5}$ of the whole weight of water. Then—

$6^2=36=$ the pounds avoirdupois of 3 feet of the column of water; but the column is 30 feet, therefore $3:30::36:360$ pounds, the weight of the whole column. Adding the friction we have $\frac{360}{5}=72$, and this added to the weight of the column gives $360+72=432$: and to this add the weight of the piston and pump rod, $432+10=442=$ the whole resistance, which anything greater will overcome.

If the pump handle be in the proportion of 10 to 1, the pump may be wrought with a force of 45 pounds.*

The *Body Post* and *After Deadwood* are bored through in a fore and aft line, and the passage thus formed is bushed with two metal pipes, through the innermost of which the screw shaft projects. The fore part of this pipe is made water-tight round the shaft, by a collar and packing called the gland box, which is put on inside the ship; the after end is lined with strips of lignum vitæ. The projecting end of the shaft is fitted, on its appearance outside, with a metal head-piece into the mortise or "slot," of which the foremost end of the boss of the screw drops; and this connection is made permanent by the downward pressure of rods called Spanners, which reaching from the deck are screwed down upon the frame when the boss has entered. The mortise must of course be turned upright either to receive the screw or permit of its disconnection; the screw being kept upright during these operations by means of a moveable trigger, which is so arranged as to catch the upper blade when necessary. The shaft is made in pieces of about 24 feet in length, which are connected by fastenings called couplings.

The after part of the body and fore part of the stern-post, are fitted with metal bearings on which the bosses of the screw rest when it is in place. They are also faced by groovings of metal, which serve to guide the screw during its ascent or descent. These groovings are fitted with metal racks; the screw is suspended in a framing commonly called the banjo, from which corresponding pauls project; and which, being permitted to act upon the racks whilst hoisting the screw up, prevent danger in the event of the ropes being carried away. There is no such pro-

* Grier's Mechanic's Calculator.

vision made for lowering, and therefore great care is taken to attend the falls during that operation. The diagrams connected with the article on steam may explain this fitment more clearly.

MEASUREMENT FOR TONNAGE.

The Common Rule for finding the burthen of ships, or what is called the builder's tonnage, is to multiply the length by the extreme breadth, and that product by half the extreme breadth, and divide the product by 94 ; thus : length × extreme breadth × half the extreme breadth = the builder's tonnage.

The following is called the Parliamentary, or new rule : divide the length of the upper deck between the after part of the stem and the foremost part of the stern-post into six equal parts. Depths : at the foremost, middle, and aftermost of these points of division, measure in feet and decimal parts of a foot the depths from the under side of the upper deck to the ceiling at the limber strake. In the case of a break in the upper deck, the depths are to be measured from a line stretched in a continuation of the deck. Breadths : divide each of those three depths into five equal parts, and measure the inside breadths at the following points, viz. : at $\frac{1}{5}$th and at $\frac{4}{5}$ths from the upper deck of the foremost and aftermost depths, and at $\frac{2}{5}$ths and $\frac{4}{5}$ths from the upper deck of the midship depth. Length : at half the midship depth, measure the length of the vessel from the after part of the stem to the foremost part of the stern post ; then to twice the midship depth, add the foremost and aftermost depths for the *sum* of the depths : add together the upper and lower breadths at the foremost division, three times the upper breadths, and the lower breadth at the midship division, and the upper and twice the lower breadth at the after division, for the sum of breadths ; then multiply the sum of the breadths by the sum of the depths, and this product by the length, and divide the final product by 3500, which will give the number of tons for register. If the vessel have a poop or half-deck, or a break in the upper deck, measure the inside mean length, breadth, and height of such part thereof as may be included within the bulk head : multiply these three measurements together, and dividing the product by 92·4, the quotient will be the number of tons to be added to the result as above found. In order to ascertain the tonnage of open vessels the depths are to be measured from the upper edge of the upper strake.

AMOUNT OF MATERIALS.

Although ships have increased in size considerably since the publication of Mr. Edye's calculations, a selection from that work will serve to exemplify the amount of materials employed in the construction and equipment, as well as the value of a 120-gun ship. Timber, 2197; iron, 136; copper bolts, 47; copper sheets, 18; metal nails, 3; pintles and braces, 2½; lead, 9; oakum, 16; pitch and tar, 16; whiting and white lead, 9½; oil, 1½; three coats of paint, 9½; spars, 106; rigging, 60; sails, 11; cables and anchors, 90; ballast, water, fuel, guns, ammunition, provisions, stores, 1860 tons; rope, 30,250 fathoms; blocks, 950; and trenails 64,456 in number.

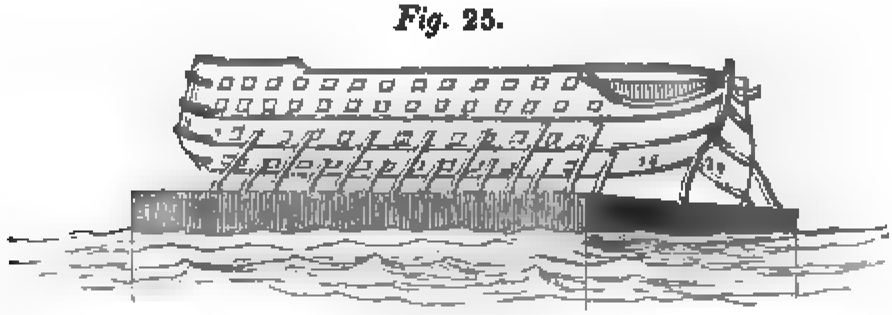
Weight of the hull when launched, 2466 tons. Total weights received on board, 2143 tons; expense of labour, 15,643*l.*; of materials, 77,878*l.*; of hull, 93,521*l.*; of spars, 3879*l.*; of rigging and blocks, 2994*l.*; of furniture and sea stores, 16,805*l.*

CHAP. V.

FLOATING.

BESIDES the construction of the ship, and the formation of those places whereon she may be built, there are frequently many difficulties to be surmounted before the fruit of all this labour is freely clear of the ground. For example: — A river too shallow for even the lightest draught of the vessel, has to be navigated; a shifting sand, or newly formed bank, to be crossed; and even in some cases (as in Russia), ships must be borne bodily on

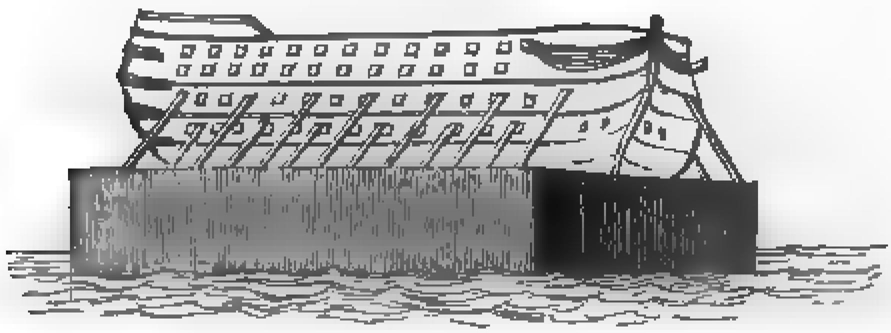
Fig. 25.



"camels," which, being first filled with water, are secured to the ship's sides, and then pumped out. (See *figs.* 25, 26.)

Again, it may be only necessary to get the ship on an even keel; for all vessels sit deeper by the stern when empty. In launching the "Bombay," *e. g.*, her heel was lifted over a bank

Fig. 26.



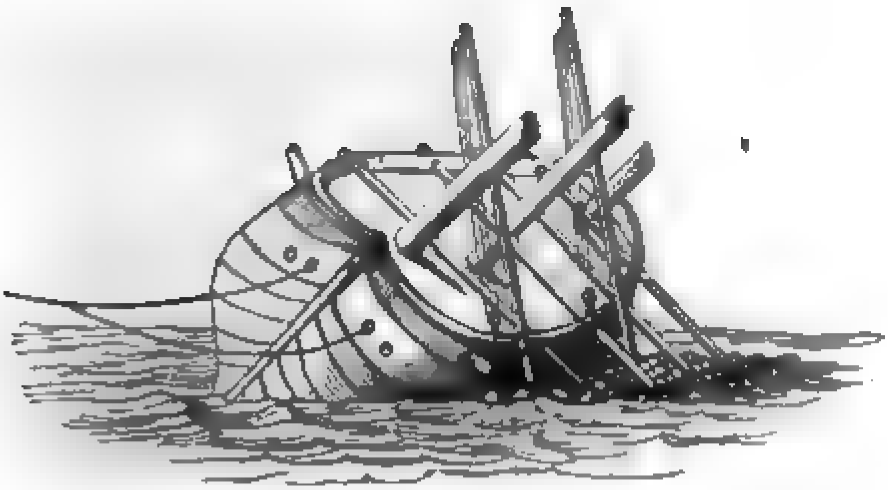
that had formed outside the dock gates, by securing several large lighters under the quarters on the same principle.

These considerations naturally suggest a notice of those purposes, to which a knowledge of the laws of fluid pressure we have already noticed may be applied.* Often in danger of foundering or grounding, and frequently called upon to convey weights into shoaler water than the ship's draught will admit of, we must be prepared to assign to every boat, spar, and other buoyant body its due amount of duty. The "Sulphur" grounded, and falling over in a tidal harbour, became filled with water at each flow of tide. Rafts of spars were constructed, and at low water lashed to the leeside. Larger spars were secured athwart the upper deck, whose ends projecting beyond the sides, rested on those rafts; up and down spars were also placed on the leeside, their heavier ends resting on the ground, and tackles brought from their heads to that side of the ship. Between the action of these tackles, and that of the rising tide on the raft, the vessel was finally uprighted. (See *fig.* 27.)

In 1801, the Dutch frigate "Ambuscade," carrying a press of sail with the wind right-aft, imperceptibly shipped so much water through the hawse holes (which in those times were very large and low) as to go down suddenly when near the Great Nore.

* Chap. 1.

Fig. 27.

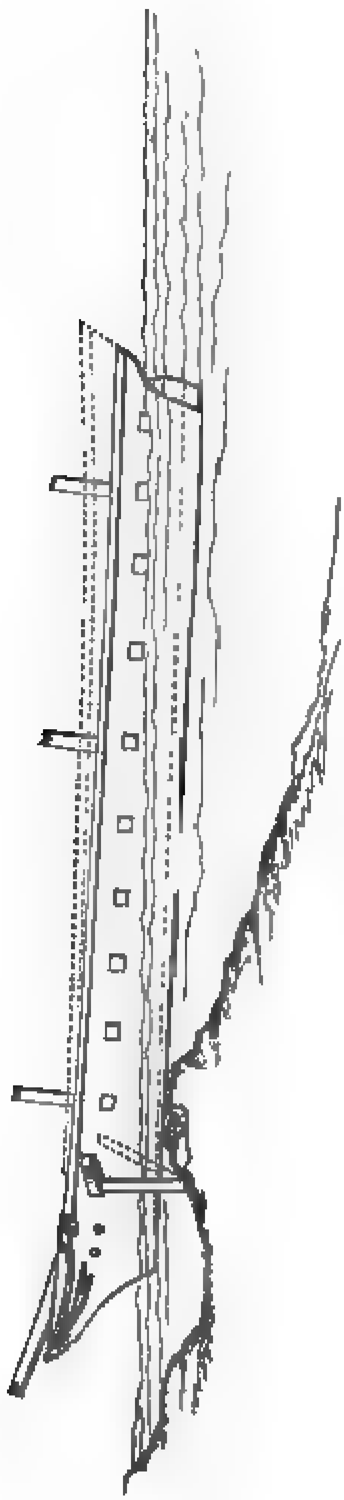


At low water she was slung by cables rove through the ports, and which were secured to five vessels, one being of 1063 tons, the others of 100 tons burthen each. These cables, as well as one from an anchor laid out ahead, for the purpose of overcoming the cohesion of the silt, were hove taut with purchases; and as the tide rose, the vessel was carried uninjured into harbour, and eventually pumped out.

But the most remarkable triumph of ingenuity and perseverance on record is found in the case of the "Gorgon." This vessel, a steamer of nearly 1200 tons, and 320 horse power, was driven on shore in a gale, and embedded in the sand, to a depth of almost 12 feet. Camels were constructed on the spot, tanks made water-tight by introducing fearnought and lead with their lids. Boilers were hoisted out and also made water-tight, and these with casks, &c., affording altogether a buoyancy equal to 367 tons, were secured under the ship, by means of cables passed round the bottom. These appliances, with the assistance of some screws, rescued the ship from her perilous condition, and the whole operation presents a picture of united energy and skill to which maritime records afford no parallel. The details of these operations have been narrated by one of the "Gorgon's" officers, as "not only an account of the means used to restore the ship, but likewise to point out to the young officer to what advantages the qualities of perseverance and forethought may be applied, *if duly cultivated in early life.*"*

* Recovery of the "Gorgon," by Captain Key, R.N.

Fig. 28.



In case this work should not be within reach of reference, the dimensions of one of the camels, whose buoyancy was equal to 62 tons, may be useful.

The planking was of 3-inch fir, doubled at the edges, and nailed on over 7 frames, whose scantling was 9 inches by 5.

Length - -	36 feet.
Height - -	7 feet 4 inches.
Breadth on top -	5 feet 10 inches.
Breadth of bottom	10 feet 4 inches.

Although not exactly a case in point, the story of another heaving off which occurred lately will prove the value of a familiar acquaintance with natural science.

The ship had been run stem on very hard, and after unavailing efforts to get her off, hung on a rock abaft the fore-mast. The weights were run aft; balks of timber were placed athwart ships before the place where the ship hung, projecting through the ports; perpendicular shores were placed under these from the ground; stages slung to the balks, and wedges prepared for driving between their outside ends and the shore heads; opportunity was then taken of the first increase of water to set up the wedges, remove the after weights, and heave in on the purchases at the same time. On this, the ship started immediately; and, by a repetition of the same process of leverage, was completely cleared of the shore.* (See *fig.* 28.)

* The dark lines are meant to show the first position: the dotted ones the second.

In using *tanks* or *casks* the internal capacity is found by multiplying the gallons by 10, which is the number of pounds in a gallon of water; subtracting the weight of the tank or cask, the floating power will be attained.

One cubic foot of water is equal to 6·25 gallons, and each gallon to 277·274 cubic inches.

Having borrowed from Mr. Edye the means of ascertaining the bulk of the regular spars, we shall refer to Sir Howard Douglas for the following Rules and Tables for ascertaining the buoyant capacities of irregular ones.

"To find the quantity of timber required to float a given weight, the solid content must be first known.

"To find the solid content of a tree 30 feet long, having the girth of the two ends 65 and 52 inches: —

"Multiply the square of the mean girth expressed in feet and decimals, by ·07956 (the area of a circle whose circumference is 1), and the product by the length.

$$\begin{array}{rl} & 4.33 \\ & \underline{5{\cdot}41} \\ 2) & 9{\cdot}74 \quad 4{\cdot}87^2 \times {\cdot}07956 \times 30 = 56{\cdot}6 \text{ cubic feet.} \\ \text{Mean girth} & \overline{4{\cdot}87} \end{array}$$

Or, multiply the square of $\frac{1}{5}$ of the mean girth by twice the length: —

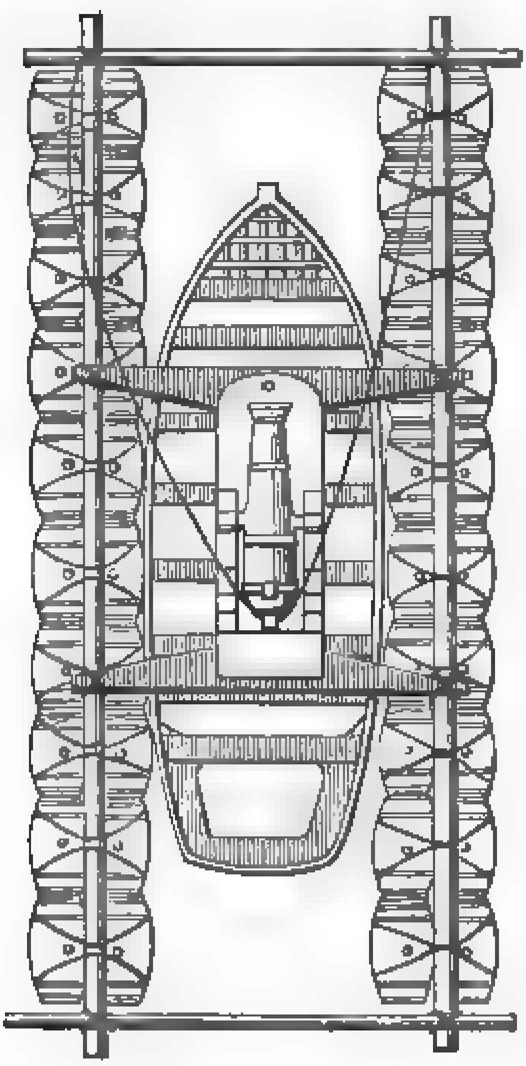
$$\begin{array}{l} 5)\underline{4{\cdot}87} \text{ mean girth of former tree,} \\ \quad {\cdot}974 \text{ and } {\cdot}974^2 \times 60 = 56{\cdot}92 \text{ cubic feet.} \end{array}$$

"The quantity of water displaced by the total immersion of a piece of timber is equal to its solid content, and the difference between its weight and that of the fluid displaced, is the weight the tree will float. The weight for instance of a cubic foot of sea water is 1026 ounces, and that of male fir 550, which therefore will float 476 ounces.

"If the content of a tree in feet be multiplied by the difference between its specific gravity and that of the fluid, the product will be the weight in ounces which the tree will float. Thus, a fir tree whose content is 56·6 feet; 56·6 × 476 = 26,941 ounces or 1684 pounds in sea water.

neighbour, figure-of-eight ways, so that they will not separate on being moved. Hoist them out, and place them one on each side of a boom boat; steady them there. Lay two spare half anchor stocks flat side downwards across the boat, the length of the gun slide apart. Chock them up underneath from the gunwale strake, and lash their ends well down to the spars. Place the gun slide on the stocks, either securing the foremost end with a lashing, or boring a hole for the fighting bolt. Lash a smaller spar across the ends of the large ones; put the gun on the slide, and, allowing for recoil, fit a breeching, with a piece of hawser

Fig. 29.



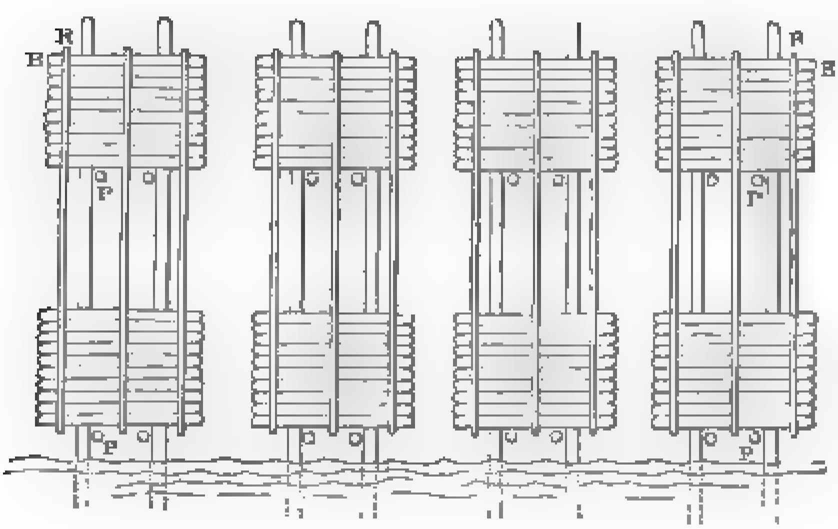
long enough to clench over the foremost ends of the large spars. The boat serves as a cabin, besides giving some 5 tons additional buoyancy. The ammunition would be carried by a small boat veered astern.

Four butts, slung under the bows of a 32-foot barge, will give her sufficient buoyancy for a 32 pounder; and if a platform of hammocks be formed in the bottom, it may be fired without injury to the boat.

RAFT OF TREES. (*Fig.* 30.)

This raft was composed of firs of an average diameter of 10 inches, and made in four sections, each of these being 30 feet long and 13 feet wide. They were crossed on the upper surface of their longest united length by spars 52 feet long, each placed top and butt alternately; the whole structure measures 52 by 30 feet.

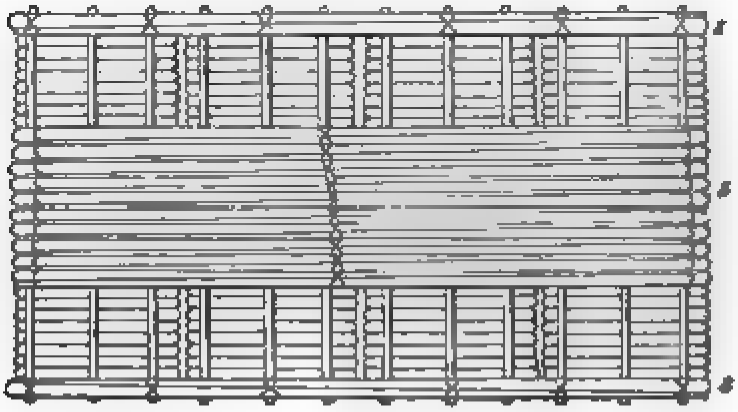
Fig. 30.



The spars used were cut at a distance of half a mile from the beach, and were selected, felled, lopped, cut into requisite lengths, transported, and formed into a raft in two days, of seven working hours, by 20 carpenters and a working party of 100 men. Eight 52-foot spars were first cut and placed in pairs on the beach, perpendicular to the water, into which their small ends projected; each of these spars being about 8 feet apart from its fellow. Their butts and middles were chocked up, so as to give

greater inclination for launching. Posts were then driven in as at P. During the transportation of the long spars, the carpenters were employed preparing eighty balks of 13 feet long each, and these were carried off and placed, as at B B. Lastly, twelve 30-foot spars were placed on the balks, as at E E, and these balks and last-placed riders were cross-lashed together. The pegs were then

Fig 31.



removed, the ways covered with sea-weed, and the four rafts launched. Twelve more long spars were launched along with the other eight; and the rafts being brought with their longest sides together, the large spars were hauled across them, and the whole became united by lashings in several places. (*Fig.* 31.)

We have said that "bodies of greater densities than water, when completely immersed, lose just as much of their weight as that of the quantity of water they displace;" and it will be well to remember the use that may be made of that hydrostatic law in the case of raft or boatwork. With a raft constructed for the purpose of floating a shipwrecked crew, a great portion of cargo might be carried underneath, the raft being thereby relieved of weight. A cask of salt beef, for example, of 300 pounds, thus disposed of, would only weigh 116 pounds. In carrying guns, anchors, propellers, rudders, &c., underneath boats, a certain quantity of their weight would also be sustained by the water. For example, a gun is (say) 67 cwt., and 7 inches in the bore. The weight of the gun in pounds divided by 440, which is the number of pounds of iron in a cubic foot, gives a quotient of 17·054, which is the number of cubic feet in the gun. 17·054 cubic feet of water multiplied by 64, which is the weight

of a cubic foot of water, gives us 1091·456 as the weight of the water which is displaced by the gun: hence, by the hydrostatic principles which we have already considered, the difference between these two sums, viz. the weight of the gun, 7504 pounds, and that of the water, 1091 pounds, shows that the gun, when suspended under water, weighs only 6413, or about 9 cwt. less than it would in the air.

Putting the tompion taut in, and closing the vent, would of course add to the displacement, and consequent diminution of weight; for a cylinder of the same dimensions as the bore would contain 2·672 cubic feet; the weight of water displaced would then be 1262, and that of the gun 6242 pounds, about 11 cwt. having been lost by immersion.

The weight of an anchor, propeller, rudder, or mass of stone, &c., when under water, can of course be estimated in like manner, especially as the Tables furnished contain the actual and specific gravities of such different substances as we are likely to come in contact with.

The following are the results of some experiments made for the purpose of ascertaining the loss of weight experienced by different bodies when immersed in sea water.

	In air.		In water.	
	lbs.	oz.	lbs.	oz.
Brass (cast) - - -	16	0	14	2
Iron - - - - -	28	0	24	0
Shingle ballast - - -	14	0	7	0
Cordage - - - -	112	0	14	0
Small arms - - - -	11	0	9	0
Lead - - - - -	10	0	9	0
Copper - - - -	9	0	8	0
Salt beef - - - -	3	4	0	1½
Coals - - - - -	7	0	1	2

"A suit of clothes and a pair of boots, which weigh 7 pounds in the air, when well saturated with water, only weigh in water 1 pound."—*Art Manual.*

SPECIFIC GRAVITY.

The scientific term "specific," which is always used in a comparative sense, means that the proportions of the body spoken of

have reference to that of some other body. Specific gravity—or, in other words, the comparative density of different substances—enables a calculator to ascertain the bulk of a substance, if its weight be given, or the weight if the bulk be given. To effect this of course requires the existence of a standard; and with respect to solids and liquids, that standard is distilled water, of which 1 cubic foot weighs 1000 ounces avoirdupois.

The specific gravity of a *solid* body is ascertained (in general) by ascertaining the difference of its weight in air and in water. It may be that some substances are heavier and some lighter than water. In the former case, the weight in air, then in water must be obtained, and the first quantity being divided by the difference between the two quantities, the result will be the specific gravity of the body. On the other hand, some substances are lighter than water. In that case, their weight in air is united to that (in water) of a second substance applied to it to make it sink, and the sum of the two reduced by the weight of both in water. If we then divide the first quantity by the difference obtained by reduction, the result will be the specific gravity of the substance. It is sometimes convenient to find the specific gravity of Fluids. To do this, we must take some solid substance, heavy enough to sink by its own weight in the fluid, whose specific gravity we have previously ascertained, which we must weigh both in the fluid and in the air. If we take the difference between these two weights, and multiply it by the specific gravity of the solid, and divide the product by the fluid's weight in the air, we shall arrive at the specific gravity of the fluid.*

"The specific gravity of a substance is therefore the number of units of weight contained in a certain known *volume* or *bulk of it;* which known volume or bulk is usually taken to be one unit of the whole volume or bulk. The units of weight used in measuring the specific gravity of a body, are not the same with those used in determining its ordinary weight. Thus we do not say that the specific gravity of a body is so many pounds in the cubical foot, or inch, meaning by the term, 1 pound, the weight

* Generally speaking, it is convenient to take the rule that one cubic foot of water = 1000 oz. avoirdupois. But sometimes, as above, water may be taken as unit; thus water sp. gr. 1 or 1000; iron, 8 or 8000; platina, 21·5 or 21,500; the latter numbers expressing absolute weight in ounces of a cubic foot of the substance.

of a certain quantity of water, determined as explained. But to measure the specific gravity of a body, we always take, for our unit of weight, the weight of a quantity of water of the same volume with one unit of the volume of the body, whatever that unit may be. Thus, if the volume is measured in cubic inches, the unit of weight used in fixing its specific gravity is the weight of one cubical inch of water." . . . . "The specific gravity of the body is, in point of fact, no other than the number of cubical inches of water equal in weight to one of *its* cubical inches. So if the body be measured in cubical feet its specific gravity is the number of cubical feet of water whose weight shall equal one of *its* cubical feet. Thus, in the table of specific gravity the number 8·900 stated as the specific gravity of copper, means that each cubical inch, or cubical foot of copper weighs the same with 8·900 cubical inches or cubical feet of water. Thus, knowing the number of cubical feet in a body, and knowing its specific gravity, we can tell how much water it is equal in weight to, by multiplying their specific gravity by the number of cubical feet — this specific gravity being in fact, the number of cubical feet of water equal in weight to each cubical foot." *

Rule.—To determine the magnitude of any body from its weight: —

As the specific gravity : to its weight in ounces :: 1 cubic foot : its contents in cubic feet or inches.

To determine the weight from the magnitude: —

As 1 cubic foot, or 1728 cubic inches : contents :: its specific gravity : weight.

* Moseley's Mechanics.

CHAP. VI.

STOWAGE.

The Stowage of a ship has reference to stability, speed, easiness of motion, economy of space, and convenience of access, and is therefore a subject of the greatest importance. In the distribution of the disposable weights, the first thing to be considered is the Ballast. Its quantity, which is proportionate to the weight of guns, masts, and other top weights, is determined by the builder when designing the ship, whose form and size are so arranged that she will carry the proposed quantity without being too much immersed.

The purpose of ballast is to increase that quality in a ship called Stability, which enables her as much as possible to resist inclination, and to recover her upright position. And as it seems impossible to accomplish this without the existence of some weight which will counterbalance the disturbing forces of wind and water and the top hamper of the armament, the supply of ballast is, in the first instance, stowed on the bottom of the ship. For, the weights above water are generally fixtures; whereas those below, such as water, provisions, fuel, &c., are necessarily diminished by consumption. If, therefore, there were no ballast, and the weights below water-level were removed or reduced, the equilibrium would be dangerously affected, and the ship could neither fight her guns, nor carry a sufficiency of sail to be weatherly or speedy. It is true that a partial remedy would be found in filling the tanks with salt water, but it must be well remembered that mere immersion does not give stability. With her crew sitting on the thwarts, or standing up, or seated on the bottom, a sailing boat will have the same immersion, but very different degrees of *stability*.

The Weight of ballast in modern times is much less than formerly, on the idea that the increased solidity of the several appliances required in a ship added much to her stability. Whether this were a correct supposition or not, other circumstances defeated the supposed advantage. Thus, Mr. Fincham observes:—"In the year 1783, the larger class of three-decked

ships had 340 tons of shingle, and 140 tons of iron ballast. In 1812, they had 60 tons of shingle and 340 tons of iron ballast; and when, some years later, iron tanks were supplied for the ground tier, the use of shingle was discontinued. The extent of change that has taken place may be illustrated by the 'Caledonia,' of 120 guns. In 1814 she had 340 tons of iron ballast and 60 tons of shingle; and on being fitted out in 1835 she had no shingle, and only 177 tons of iron ballast; and at the present time, the ballast of three-decked ships varies from 100 to 230 tons."

"Fixed rules have been given at different times to determine what quantity of ballast should be used, and at present it is much less than it was formerly, as the greater dimensions which are now given to ships have increased their stability, whilst the solidity of the timbers of the frame, chain cables, iron tanks, and other heavy weights, which are now put on board ships, increasing the weight below, and lowering the centre of gravity, have still further added to the stability. The advantages in point of stability which were thus gained, have been partially lost by the recent increase in the weight of the armament which is now borne by ships in the British navy, an increase which is not wholly balanced by the greater quantity of shot and shell that is stowed in the hold." *

Thus, the experiences of former times appear to be in favour of ships carrying large proportions of ballast. The days of St. Vincent supply instances of lengthened cruises made by ships in company in large numbers. The fleet of Nelson chased across the Atlantic twice, each ship holding her place.

Whether these remarkable facts were the consequences of powerful stability resulting from ballast, or merely those of a very high order of seamanship, they are deserving of deep consideration.

As, in general, stability will be increased by increasing the depth of the centre of gravity below the centre of buoyancy or displacement, it may be well to define these terms.

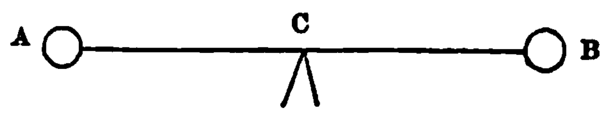
The Centre of Gravity of any body is usually defined as that point upon which the body would balance itself in any position, when acted upon *solely* by the force of gravity. Its tendency is always to assume the lowest position that it can have com-

* Fincham's Outlines.

patibly with the conditions in which the body is placed; consequently, when it is in such lowest position, the body will be in stable equilibrium.

The same definition is applicable to the Centre of gravity of any system or combination of bodies. Suppose a rod to have two equal weights, as at A and B. The point C, upon which it would balance, is the common centre of gravity of those weights. But if any increase or diminution of weight were to take place on either side of C, the balance would be destroyed, and C would no longer be the centre of gravity; and to restore the balance, the prop must be moved towards that side where there was a preponderance of weight; from which it appears that the relation

Fig. 32.



between the centre of gravity and the weights on either side of it, is the same as that between the fulcrum of a lever, or the point of suspension of a balance and the weights which keep it in equilibrium.

In scientific investigations, the centre of gravity of any body or system of bodies, is used to represent the body or system itself, all the mass and weight being considered as concentrated at that point, and all measurements which concern their weight or its effects being referred to that point. Thus, reverting to the example above, the pressure weighing down upon the prop at C is equal to the sum of the two weights A and B, and, in any calculation involving the joint effect of those weights, that pressure and the point C at which it acts would be substituted for the action of the individual weights.

A ship with all her weights in is, in fact, a system of bodies connected together, and composed of the hull, stores, &c., each article having its centre of gravity, and the whole combined having one common centre of gravity, upon which, when floating at rest, the ship may be said to balance herself.

But the water exerts a pressure upwards equal to the whole

weight of the ship. Hence, in all questions affecting the flotation or the motions of a ship, we have to consider the effects of two antagonist forces,— the weight of the ship and the pressure of the water,—each of which must be treated as acting through its own centre of gravity; that of the former being called the centre of gravity of system, that of the latter, the centre of gravity of displacement, or immersion, or buoyancy.

A ship floating in the water, displaces a quantity of water equal in weight to the whole ship and her contents, and equal in bulk to that portion of her which is immersed. The result is that the water, in supporting the ship, presses upon all the part which is immersed with an upward pressure equal to her weight. As the surface of the part pressed upon is of an irregular shape, and as all fluids exert their pressure at right angles to the surface upon which they press, it follows that, in sustaining the ship, the water presses in an infinite variety of directions, the whole of which combined, may be represented by a vertical line passing through the centre of gravity of a body of uniform density corresponding in shape and dimensions to the immersed part of the hull of the ship. This line is called the Resultant of the pressure of the water, and the centre of gravity through which it passes, the centre of gravity of displacement.

When the ship is upright and floating at rest, these two centres are in the same vertical line, the ship herself, by the action of her own weight, adapting her trim so as to bring them into that position. But in a seaway, this state of things is disturbed. The accumulation of water in the form of a wave, changes the direction of the different pressures on the hull, and with them the resultant of the pressure; and the motion of the ship which follows, is simply a series of efforts on her part to recover her state of equilibrium or balance. For instance, a sea pressing on the bow draws the resultant of the pressure further forward than the centre of gravity of system. That point being no longer adequately supported, sinks until a sufficient pressure on her after body has been regained to bring the resultant back into its old position. As the body of the sea, carrying its resultant with it, passes under the centre of gravity of system, the ship is balanced for a moment at her ordinary trim; and as it passes aft the balance is again disturbed, and the bow sinks

until it is again restored. The rolling motion is produced by the same process.

From what has been said on the relative position of the centres of gravity and displacement, it will appear, that if it be desirable that a ship should float at a certain trim, it will be requisite to arrange the weights in her so as to insure their common centre of gravity being in a certain position. This arrangement is accomplished when the sum of the moments of the weight before the point determined on as the centre of gravity is equal to the sum of the moments abaft it *, because the effect of any weight in influencing the position of the centre of gravity is in exact proportion to its distance from it; a small weight at a great distance producing the same effect as twice the weight at half the distance.

If the trim of the ship were the only consideration, this arrangement would be simple enough, but the effects of the weights on pitching and rolling motion must also be considered.

It is a law in mechanics that, while the effect of a weight in merely depressing or balancing the arm of a lever, is as its distance from the fulcrum or axis, the momentum or power of the weight in motion (as when a ship is pitching or scending) is as the square of that distance. Thus, suppose 2 guns each weighing 5 tons, placed the one at 40 and the other at 50 feet from the centre of gravity. The moments of these guns, when the ship is at rest, will be as $5 \times 40 = 200$ to $5 \times 50 = 250$, their difference being 50; whereas their momenta will be as $5 \times 40^2 = 8000$ to $5 \times 50^2 = 12500$, the difference being 4500. These figures will give some idea of the extent to which heavy weights placed at the extremities of a ship may aggravate her pitching in a sea way, and show the wisdom of concentrating them as much as may be convenient.

There are many disposable weights, in the distribution of which we may develop, or fail to develop, or even defeat, the design of the builder; for although a ship when at rest may be apparently in the best sailing trim, it does not follow that she is so in reality. A certain line of flotation might be produced by stowing one half of the disposable weights in the fore end, and one half in the other; or the whole might be stowed in the centre. In either case the ship might, according to the copper marks, be correct as to

* *The term* "*moment*" meaning the product of any weight multiplied into *its distance from the* centre of gravity.

a stipulated measure of draught, but the instant she entered uneven water the difference in the modes of stowage would be manifest. In the former case she would plunge heavily, strain her fastenings, and break her cordage or machinery, and stop her way; in the latter, all would be the reverse.

For a ship, when at rest, is not equally water borne at *all points*. The fuller midship sections are pressed upwards, whilst the finer extremities are sustained, partly by the water and partly by their connexion with the central body. There is, consequently, such a constant tendency in the foremost and after ends to droop, that when ships are cleared of their material, it is found necessary to load them with ballast, until all parts derive support from the water, and thus to correct as much as possible the natural inclination to "hogging."

It can easily be understood that, by stowing weights at the extremities, not only is the "hogging" tendency encouraged, but (when, as in a sea way, the water has altogether receded from under the fore-body and the wave has passed the centre) the ship will plunge heavily until the bow meets with a material resistance. In this way, the best of ships unfairly acquire an unenviable reputation for pitching.

Foreseeing these possibilities, we find one architect saying, "A ship badly constructed, whose faults are to be corrected by stowage, will sail badly; and that which is well constructed, if badly stowed, will do no better: the stowage, therefore, is an essential, difficult, and delicate part of a ship's economy, to perfect which the officers do very properly to act in concert with each other." * And, another, "A ship of the best form will not show her good qualities except it is at the same time well rigged, well stowed, and well worked by those who command it." †

"If we were to rely confidently upon all that has been said of the great effects on the sailing of ships, resulting from the moving of small weights, we should hardly know how to limit the importance of stowage; but whilst the extent to which small changes are said to affect the sailing of ships may seem questionable, the fact is established beyond all dispute, that along with alterations in the trim of most ships their sailing qualities are altered. Experience has shown that the magnitude of such

* *Du Hamel.* † Chapman.

effects depends greatly on the form, some ships being more easily put out of trim than others. The investigation of the subject requires yet to be pursued by practical means, for hitherto much is uncertain." * There appears to be more ground for the belief in the effect of small changes on the sailing of ships than this eminent architect seems prepared to admit.

The story of the difference of the speed between two horses, hitherto equal, arising from the circumstance of one rider having inadvertently carried the key of the stable in his pocket, is certainly not much more incredible than the records of ships under trial. But without contending for the possibility of pace being dependent on such extreme nicety, there can be no question about the tender sensibility of some ships. During one of the trials between the "Barham" and "Vernon," the captain, on coming on deck after a very short absence, exclaimed, that there was something wrong. It proved that a 5-inch hawser, which had been spread on the booms near the main mast to dry, had been in the interval reeled up near the bowsprit. On another occasion, when both ships were sailing abreast on a wind, and neither gaining, the men who were lying on the deck round the mainmast were caused to stand up, and instantly the "Barham" moved ahead. The "key" to this refinement of sailing quality was found on the quarter-deck; but the principle and cause of the success evidently lay in a great attention to stowage.

And this brings us to the problem of stability, or the resistance of a ship to the pressure of her canvass, which is capable of the same explanation as the pitching and rolling motions.

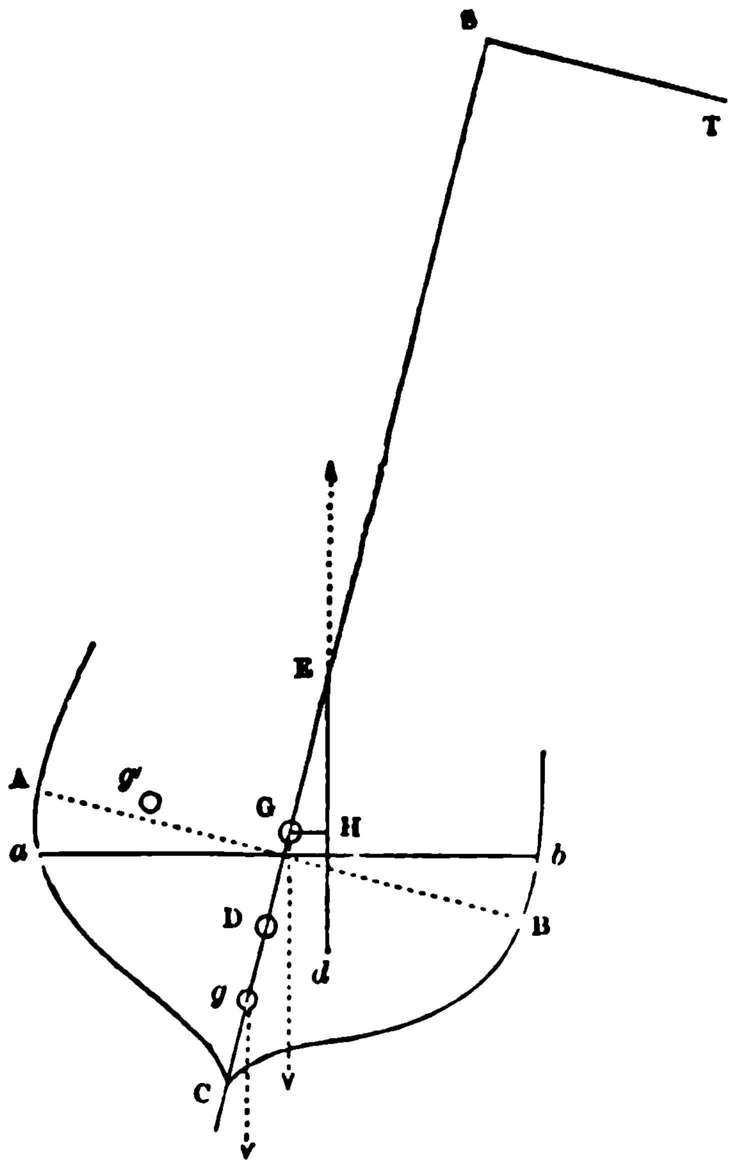
The pressure of the sails acting at their centre of effort on the masts, heels the ship over, and, in doing so, virtually alters the shape of her immersed portion; by which alteration the resultant of the pressure of the water and the position of the centre of gravity of displacement are also changed. The centre of gravity of system remaining fixed, the resistance to the heeling power is the effort of the ship to recover her state of equilibrium, and to bring the two centres of gravity back into the same vertical line.

In the annexed figure, A B C represents a ship heeling under canvass: her centre of gravity of system being at G: A B the

* Fincham's Outlines.

water line, and D her centre of gravity of displacement when upright: *a b* her water line, and *d* her centre of gravity of

Fig. 33.



displacement when heeled over; its position, having undergone a change consequent on the change of form from A B C to *a b* C, produced by the inclination *d* E, is now the resultant of the pressure of water. The action of the different forces may be thus briefly explained. As the ship, on heeling, turns round an axis passing through her centre of gravity, G S may be considered as a lever, S the centre of effort of the sails pressing in the direction S T to heel the ship, *d* the displacement (equal to the whole weight of the ship) pressing upwards in the direction of the resultant *d* E to right her.

Draw G H at right angles *to d* E. *By* a principle of the lever, the *power exerted by any force, acting* obliquely on a lever, is

proportionate to the distance from the fulcrum at which it acts, that distance being measured on a line perpendicular to its line of action. In the case before us, therefore, the displacement or weight of the ship multiplied into G H, constitutes the force exerted to right her.

From this it appears that the longer the line G H can be made at a given angle of inclination, the greater will be the stability of the ship. This may be done in two ways, 1st, by lowering the centre of gravity of system, which is effected either by adding to the quantity of ballast, or by lowering some of the weights already existing in the ship; 2ndly, by drawing the centre over to windward, by means of shifting the ballast.

The point *g* illustrates the first method, and *g'* the second. In either case a perpendicular drawn to the line *d* M from these points would be longer than G H.*

Both these methods of increasing stability are practicable, and are constantly resorted to in boats. The first, by filling the breakers, and making the men sit down in the bottom of the boat; the second, by making the men sit up to windward. Of the two, the *former* is unquestionably the safer, as the increase of stability is permanent on either tack; whereas, when the latter method is adopted, if the boat should be suddenly taken aback, before there is time for the men to regain their proper seats, all the gain of stability on the one tack is exactly so much loss of stability on the other; and an upset must be the consequence. This catastrophe has been known to happen in passing under the stern of a ship, in a strong breeze, from the eddy wind taking the sails in reverse.

It has been supposed that efficient stability could be given under all the circumstances to which a man-of-war is subject by *Form* alone, without any ballast; a supposition founded on the results of further experiments with models. Masts were erected on forms, each having different shape, but being perfectly homogeneous, and weights intended to measure their several inclin

* The point M at which a vertical line, drawn from the true centre of gravity of displacement, cuts another that has been drawn from the former one, is called the metà centre. By studying the direction of the different forces, indicated by the arrows, it will be obvious that unless this point be above the centre of gravity, the vessel would upset.

tions were attached to lines, leading from the mast heads over adjoining pulleys.

Fig. 34.

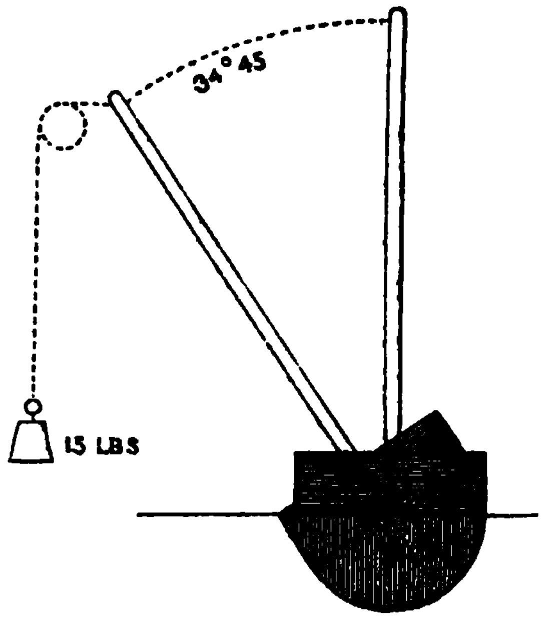
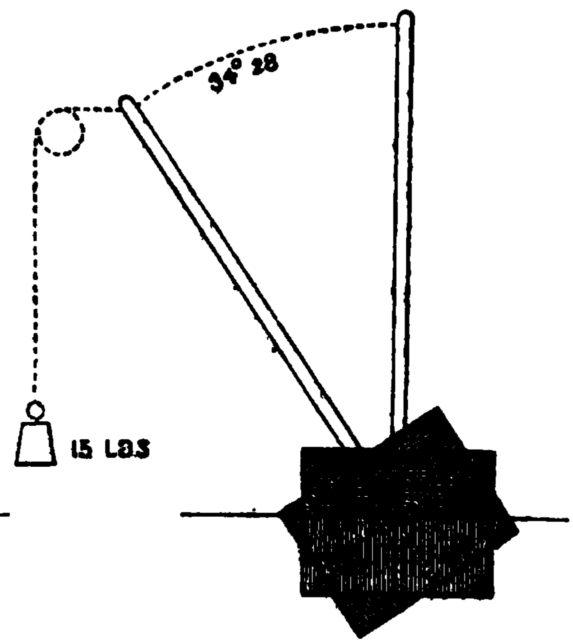


Fig. 35.



Here we were supposed to have discovered the form for stability unerringly, and amateurs flattered themselves that they had solved a question which the most experienced architects have

Fig. 36.

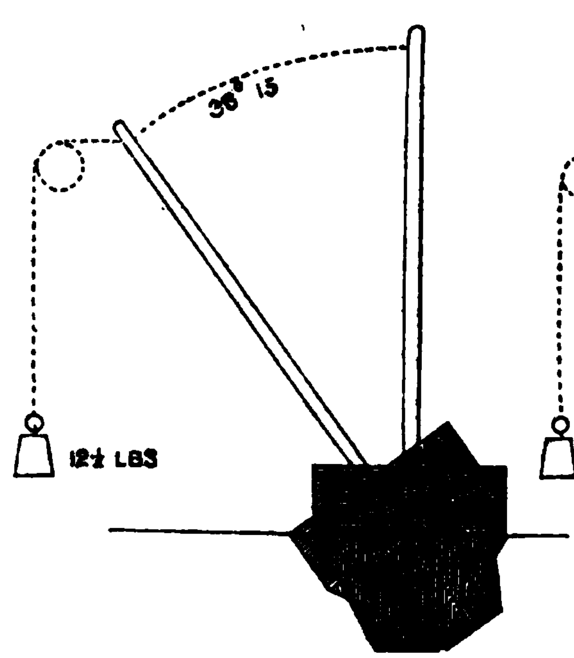
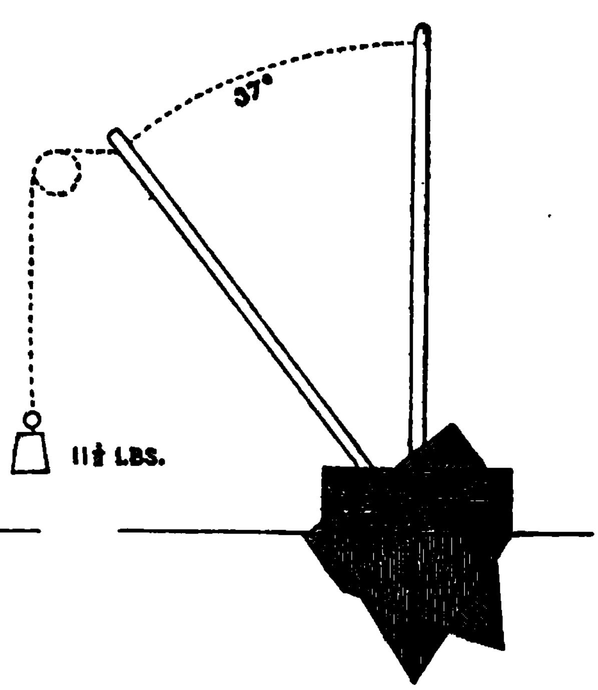


Fig. 37.



admitted to be "pregnant with the most intricate difficulties; to surmount which seems to exceed the force of human understanding."

"*Fig.* 34. exceeded *fig.* 35. in stability, till the weights amounted to 13½ lbs., after which the excess was with *fig.* 35.; 36. was inferior to 34. and 35.; and 37. inferior to all. Thus the power applied was *similar in its effects to the force of the wind!*" *

If the experimentalist had ever been in broken water, he might have discovered what is well known to every coxswain of a jolly-boat, that when a vessel is taken in a squall, having no way on, she inclines much more at first than she does after gathering, way; and this is such a practical illustration of what Clairbois himself says on this very point that it seems unnecessary to argue on the unprofitable nature of all such experiments and the utter fallacy of the conclusions which have been drawn from them. "There is a Hydrostatic or Theoretic stability, which is only true when the ship has no progressive motion, yet under other circumstances, *it differs widely* from the Hydrodynamic or Practical stability." † In the above case, stability is considered with reference to only one disturbing element, the wind; but the effects of water in motion are entirely overlooked. In fact, experiments made in cisterns, however interesting in a lecture-room, and successful in Virginia Water, are inapplicable to the rough practice of sea-faring vessels. How far the stability or general efficiencies of a ship should be derived from weight, and how far from form, is a question which must be decided by judgment and experience gathered under canvass. The laws by which their action is regulated, and the manner in which their influence may be augmented or diminished, constitute a department of knowledge in which every sea officer should be well grounded.

The following Table will convey an idea of the effects which may be produced by moving certain weights through different spaces. It gives the weight which it will be necessary to move a distance of 40 feet, either aft or forwards, in order to produce an alteration of 1 foot in the trim of the ship.

* Experiments by Mr. Gorge, mentioned in Charnock's History of Marine Architecture. Since making the above remarks, a recent number of the Mechanics' Magazine criticises some repetitions of these experiments.

† Clairbois' Treatise on Naval Architecture, translated by Captain Strange, *R.N.*

Class of Vessel and Number of Guns.	Length, feet.	Breadth, feet.	Weight to be moved a distance of 40 feet.
			Tons.
1st Rate - - 120	206	55	112
2nd Rate - - 84	193	52	90
4th Rate - - 60	174	44	58
5th Rate - - 46	160	41	38
6th Rate - - 28	120	34	22
Sloop - - 18	112	31	14*

The most infallible mode however of preserving trim is by use of the Water Level. A leaden pipe bent upwards at both ends is let into the lower deck beams under the planking, in a fore and aft line, as nearly amidships as the hatchways will permit, the ends are terminated with glass tubes, which are graduated, and for greater security brought up alongside some convenient stanchion. On the tube being filled, the water rises to its level at each end, and the ship's most perfect trim marked off when she is perfectly still.

Any future alterations in the trim, either from expenditure of stores, or variations of wind, are immediately denoted by the levels, and may be at once rectified by the movement of disposable weights, such as shot, any number of men, &c., so that at sea, when it would be impossible to discover the trim by the copper marks, it may be thus ascertained without difficulty; and the effects of alterations in the force of the wind, otherwise imperceptible, are declared by the amount of pressure by the head, indicated by the level.†

This instrument will appear the more valuable when it is remembered that, on carrying a press of sail, a ship always settles considerably by the head; and that unless this tendency be corrected by moving weights from the fore-body, (supposing the sails to be well trimmed,) the increased resistance will neutralise the propelling force. For although, as a general rule, the gain by carrying a press of sail is little as compared with the risk, yet there are times when that little might be of much

* Crueze on Naval Architecture.

† In the absence of a *better*, a *temporary* level may be constructed with a length *of good hose.*

consequence ; and we should be prepared, not only with good gear to press on with, but with a good instrument to inform us that speed is undiminished, if not increased.

Few things are more fallacious than the appearance of speed which a vessel's movement presents. Judging from the quantity of water dashed from her bows, and the noise made by her passage through the waves, one would infer a high rate of progress. But it is found that all this time the ship's bows are unduly depressed, and that the commotion of the water, supposed to be evidence of speed, is in fact only evidence to more water being displaced than is necessary. Thus, in a ship of the "Barham's" length and size, the depression has occasionally amounted to 18 inches ; the remedy adopted being, not that of reducing sail at the expense of propelling power, but of adjusting trim, and that by the help of the instrument described.

In treating on the subject of fluid resistance, Dr. Arnott observes :—"A boat which moves one mile an hour, displaces a certain quantity of water, and with a certain velocity; if it move twice as fast, it of course displaces twice as much water, and requires to be moved by twice the force on that account ; but it also displaces every particle with a double velocity, and requires another doubling of the power on this account : the power then being doubled on two accounts, becomes a power of four. In the same manner with a speed of three, three times as many particles are moved, and each particle with three times the velocity ; therefore, a force of nine is wanted to produce it ; and so for a speed of four, a power of sixteen is wanted ; and for a speed of five, a power of twenty-five. The corresponding numbers, up to a speed of 10, are shown in the following table:—

Speed - - -	1	2	3	4	5	6	7	8	9	10
Corresponding resistance	1	4	9	16	25	36	49	64	81	100

So that the force of 100 horses would only drag a boat 10 times as fast as the force of one horse. Arithmeticians express the relation shown in this table, by saying *that the power required to move a body in a fluid increases as the square of the speed.*"

"If an engine of 49 or 50-horse power would drive a boat 7 miles an hour, two engines of 50, or one of 100, would be re-*quired* to drive it 10 miles, and three such would only drive *it 12 miles. For* the same reason, if all the coal which a ship

could conveniently carry were just sufficient to drive her 1000 miles, at the rate of 12 miles per hour, it would drive her 3000 at the rate of 7 miles per hour; and nearly 6000 at the rate of 5 miles per hour."*

These remarks are not only interesting, but strictly practical; for they go to prove that, supposing we can counteract the tendency to settle by the head, and preserve trim, we shall beat another ship if we can out-carry her.

BALLAST

Is of iron in "pigs," of different weight and dimensions, cast with a hole in each end.

No. to a ton.	Length, ft. in.	Breadth, ft. in.	Depth, ft. in.	Cwt.	Qrs.	Lbs.
7	3 0	0 6	0 6	2	3	12
9	2 5	0 6	0 6	2	0	24
11	2 0	0 6	0 6	1	3	7
16	1 6	0 6	0 4½	1	0	12
18	1 6	0 5	0 4½			
20	1 5	0 5½	0 4½	1	0	0
21	2 0	0 4	0 4		3	22
40	1 0	0 4	0 4			

TANKS.

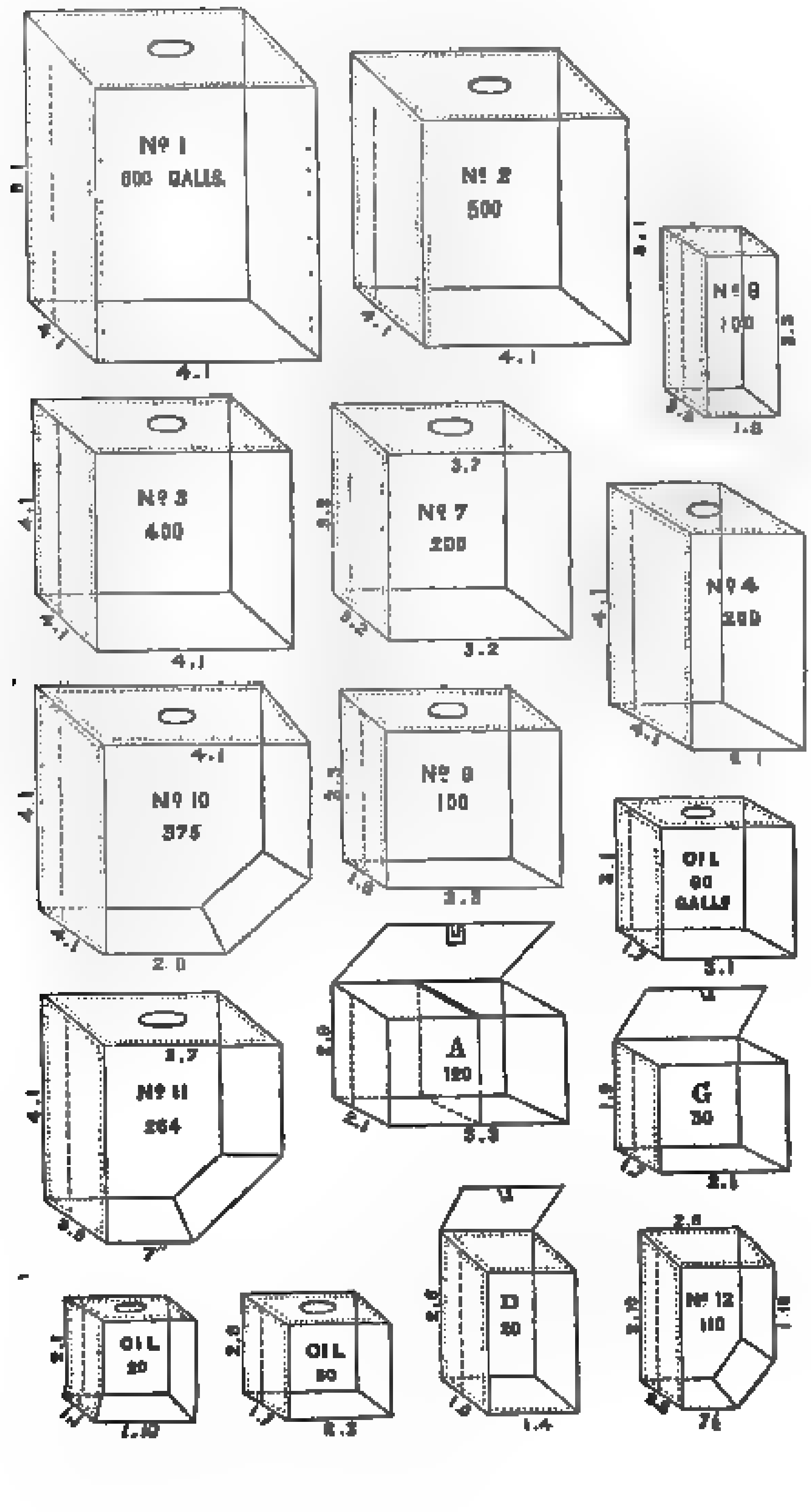
The Tanks are selected from the results of measurements made with a skeleton frame, the intervening spaces being filled in with battens, as they are stowed and chintzed. They are slung for hoisting by a toggle in the manhole; but the moment it can be dispensed with, the lid is shipped, so as to exclude dirt. When the bottom (the ground tier) is stowed, the others follow.

Whilst watering, the rod of the pump is a useful correction for a careless officer in the holds: often when the tank has delivered 100 tons, the greatest quantity of the water has, from neglect in shifting the hoses, found its way to the Bilges.†

* Elements of Physics.

† The state of the well should be regularly reported in harbour, just as at sea. Not very long since, a ship nearly ready for sea was found on a Sunday afternoon with the holds full of water. The first lieutenant, who had no superior in the service, was (for once) out of the ship, and his deputy had neglected this customary *duty*.

TANKS. (*Fig.* 38.)


Nº 1
600 GALLS.
Nº 2
500
Nº 3
400
Nº 7
200
Nº 4
250
Nº 10
375
Nº 9
150
OIL
60
GALLS
A
120
G
30
Nº 11
264
D
50
Nº 12
110
OIL
20
OIL
30

CHAP. VII.

MECHANICAL POWERS.

MECHANICS is the science which treats of forces applied to bodies, either directly, or through the agency of some machine.

Any cause which alters, or tends to alter a body's state of rest or motion, is called a Force.

The force with which we are most familiar, is that which attracts every body on the earth's surface towards its centre, and which causes the body, if free, to move towards that point; and if restrained, to press against the obstacle which prevents its motion. This force is called Gravity. The amount of the pressure exerted by different bodies varies with their magnitude. Thus, the pressure exerted by a mass of lead containing 2 cubic feet is twice as great as that of a mass containing only 1 cubic foot. Gravity is a uniform force, or in other words, exerts the same influence on all bodies which contain the same amount of matter. The pressure actually exerted by a heavy body in consequence of its tendency to fall to the earth is called its Gravitation; and that which is exerted by a certain definite bulk is called a Pound. All forces may be measured by the number of pounds weight which they could sustain if applied in a direction opposite to that of gravity, *i. e.* vertically upwards.

Besides the magnitude, it is necessary to take into consideration the *Direction* of a force.

By this is meant the straight line in which it tends to move the body, if free, and not counteracted by any other force.

Thus, if a force is produced by a thrust of a rod, its magnitude is measured by the number of pounds weight it would support if it were to act vertically upward; and its direction is that of the rod's length.

Forces applied to a body are said to be in equilibrium, when the body, if originally at rest, still remains so after their application, or, if in motion, continues to move in the same manner as before, or as if they had not been applied at all.

Velocity is the degree of quickness or slowness of a body's motion; *and, if uniform, is measured* by the number of feet

described in a Unit of time. The units of time usually employed are a Second and a Minute. The latter is the unit generally employed when the motion of machines is considered.

The principal Moving Powers are the physical force of men and animals (or living agents); the expansive force of steam and gunpowder; the action of water, and of wind; and the elastic force of metals when formed as springs.

Always directing motion, it is absolutely necessary that an officer should know how (without overtasking) to apply the "moving powers" to the greatest possible advantage, as well as to form a right estimate of "work."

Great care must be taken to have a clear understanding of the proper meaning of the term "power," as used in matters of science. It is quite distinct from strength, or force, or pressure. It always has reference to a quantity of work performed, or which could be performed. For instance, if it be said that a man can lift off the ground a piece of iron of 300 pounds weight, there is no information as to the power of a man — speaking scientifically — conveyed by the knowledge of this fact, which merely indicates his strength. But if it were stated how many such pieces he lifted to a given height, and placed upon a truck in an hour or in a minute, the amount of work which he performed would then be known, and this would be the measure of his power.

If one man loaded a truck with pieces of iron weighing 300 pounds each, and another man had to perform a similar duty with pieces of 150 pounds each, the latter must lift double the number of pieces to do the same amount of work. In this case each of these pieces must have been raised from the ground to the truck in half the time of the others; that is, two lifts for one must have been made. The quickness with which the weights were lifted is called the Velocity with which they have travelled, and this, in the case of the light weights, was double that of the heavy; and hence half the weight, raised with double the velocity, gives the same amount of work done within the same space of time, and the same amount of *power* is said to have been exerted.

In a similar manner, let it be supposed that a man in a given *time raises 10* pieces of iron, each weighing 300 pounds, that is *3000 pounds* in all, 1 foot high, and that another man raises one

of these pieces in 10 lifts one above another, each of 1 foot high, that is 10 feet in all, this will be the same number of equal lifts, and the two men will have done an equal amount of work. If the weights raised be multiplied respectively by the distances to which they have been raised, the result will be the *power*; that is, the same amount of *power* is exerted to raise 300 pounds 10 feet high, 3000 pounds 1 foot high, or 1 pound 3000 feet high.

Moreover the work done by men and animals varies according to the manner in which they exert their strength; and in consequence of their difference of form a general comparison is impossible. A man can carry a weight equal to his own, and yet his average force when thrusting at the height of the chest is reckoned at but 30 pounds. A horse cannot draw up a hill as much as three men could carry up the same; yet on a level road he would draw as much as seven men could. And either of these agents might, by a single great effort perform a piece of work, and becoming exhausted, be unfit for further labour; whilst another by a series of moderate ones, might in due time effect as great a result. So that physical force being intermittent, it can only be estimated by its effects, and hence it is that time becomes an essential part of the consideration, the question embracing, not merely the amount of action, but also the time in which it is developed.

Weight and time, and height or distance, being then interchangeable with each other, it will easily be understood that it becomes a convenient mode of expressing the power of a man or horse, to say that one man or one horse can raise a given number of pounds one foot high in one minute.

A *Unit of work* represents the labour required to raise 1 pound weight through the space of 1 foot, and has the same relation to work as a foot (which is the measure of space) has to distance, or a pound to weight. The labour expended in raising a body is found by multiplying the weight of the body in pounds by the space in feet through which it is raised. Supposing a man to raise a weight of 1 pound 1 foot high, he does a unit of work; if he lifted a weight of 160 pounds 30 feet high, he would have performed 4800 units of work, or (according to the above rule) $160 \times 30 = 4800$.

Again, if a man handed thirty 32-pound shot over the gunwale of a boat, *1 foot high, he would* perform 960 units of

work. Say that he handed at the rate of one shot a second, and that another man worked at the same rate with a luff jigger and net filled for him with three shot at a hoist, the second man would only perform the same number of units of work; for whilst the force of the first man was exerted through a space of 1 foot in a certain time, that of the other was exerted through three times the space of 1 foot in the same time. In other words, one would hand through 1 foot, and the other would haul through 3 feet of the tackle fall.

Again, if a man carry a 56-pound shot, at the rate of three miles an hour, and another of 42 pounds at the rate of four miles, the effect would be the same, viz. 168.

In the application of physical force, the individual weight of the agent must be considered as well as his muscular force.

If a man be 150 pounds weight, and he went 40 feet up the rigging, and let himself down in a bowline knot on the end of a single whip, the other end being fast to a weight somewhat lighter than his own, he would raise that weight 40 feet, and perform a number of units of work equal to the number of pounds in that weight multiplied by 40. If the end, however, were made fast to some machinery (such, for instance, as the barrel of a winch to which some weight was attached) the efficiency of the force employed would be $150 \times 40 = 6000$, and this can be caused to raise a weight of 6 pounds through a space of 1000 feet, or a weight of 1000 pounds through a space of 6 feet, or a weight of 6000 pounds through a space of 1 foot. For the mechanical effect produced by a machine is measured by the work done in a given time, or by the product of the force exerted, and the distance gone through in a unit of time in the direction of that force.

But, in thus making use of a man's individual weight, it must be observed that, except whilst raising his body, his muscular force is at rest; whereas in moving about whilst labouring, (as in working the capstan or "walking away" with a tackle fall or single rope,) he exerts his strength, both in thrusting or hauling, in addition to carrying his body; and the more nearly that is a load to him, the less can he do in addition. So that, when we can have a choice in the mode of application, it behoves us to consider *how to place* our men at their work. "The very best and most *effectual posture in* a man is that of rowing, wherein he not only

acts with more muscles at once for overcoming the resistance than in any other position, but as he pulls backwards, the weight of his body assists by way of lever." *

This remark will, of course, apply to the case of men "facing their work" at a "standing pull," for if we can place them with their feet bearing against any fixture we have just the same posture.

"The mean effect of the labour of an active man, working to the greatest possible advantage, and without impediment, is found, upon a moderate estimation, sufficient to raise 10 pounds, 10 feet in a second, for ten hours in a day; or 100 pounds 1 foot in a second, or 36,000 feet in a day, or 3,600,000 pounds 1 foot in a day." †

The Motive Powers are augmented, regulated, and directed by machinery of different descriptions. By these mechanical contrivances, a small force is enabled to overcome a great resistance, or raise a great weight, as in the case of Tackles, Levers, Screws, Wedges, and Cog-wheels whose circumferences bear upon axles of other wheels. Intermittent motion is converted into uniform motion, as in the case of the balance wheel of the land steam engine: continuous motion is obtained, as in the case of the rotatory leverage of the capstan; great velocity is generated, as in the case of the common spinning wheel, or driving wheel of some steam engines, where the circumference of a large wheel acts upon that of a smaller one; and the moving force is made to impart motion to a weight in a direction different from that in which the force itself moves, as in the case of leading blocks, of tackle falls, or the cranks, side levers, eccentric, &c. of the engine.

But these, and many other advantages afforded by machinery, cannot be obtained without proportionate disadvantage; for what is gained in force is lost in velocity or time; and what is gained in speed or time is lost in force; or, which is the same thing, when force is economised, it is at the expense of time; and, when time is saved, force is expended. This is a law in mechanics; and as power is compounded of the weight or mass of a moving body, multiplied into its velocity, it is evident that there is no increase of power properly so called in the agency of machinery.

In moving a great weight, a small force moves through a

* *Desaguliers.* † Engineers' Pocket-Book.

space as many times greater than that through which the weight moves, as the weight is greater than the force; or, the rate at which the weight is moved is so many times slower than that at which the force moves, as the weight is greater than the force. In generating a rapid velocity, the force moves through a space as many times less than that through which the weight moves, as the force is greater than the weight. And in varying the direction of motion, a greater quantity of the force is consumed in overcoming friction, than would be the case, did it act directly on the weight or resistance.

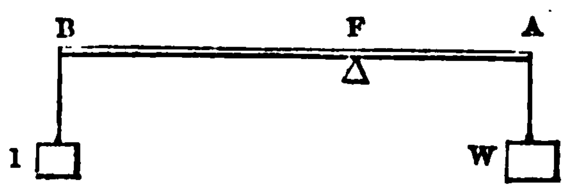
The Lever, Wheel and axle, Pulley, Inclined Plane, Wedge, and Screw, are commonly called the Mechanical Powers.

The Wheel and axle, and Pulley, are varieties of the Lever, and the Wedge and Screw of the Inclined Plane. In their separate condition, they are "simple machines," and when any number of them are combined, they form a *Compound machine.*

LEVER.

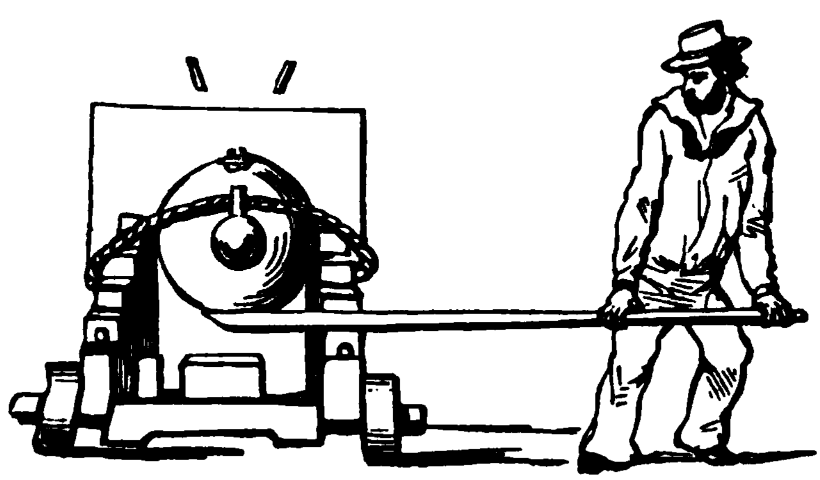
Levers are of three kinds. When the fulcrum is between the force and the weight, the lever is of the first order. (*Fig.* 39.)

Fig. 39.



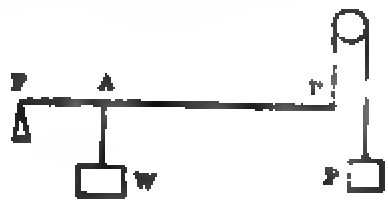
Such is the steelyard (*fig.* 45.), or pump brake, or the handspike as it is used in "raising" the breech of a gun at the order "Elevate." (*Fig.* 40.)

Fig. 40.



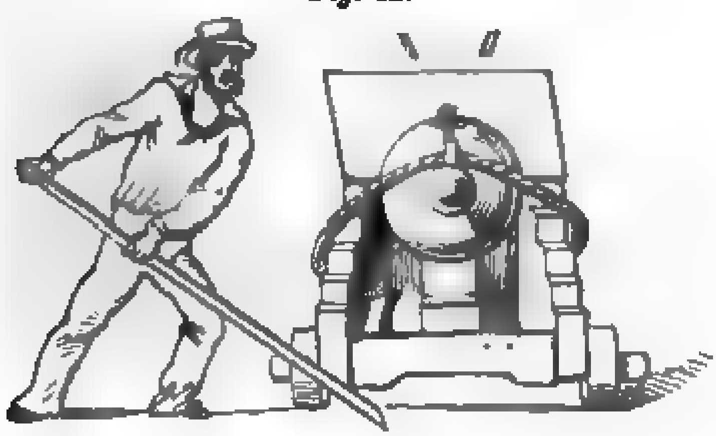
When the weight is between the fulcrum and the force, the lever is of the second order. (*Fig.* 41.)

Fig. 41.



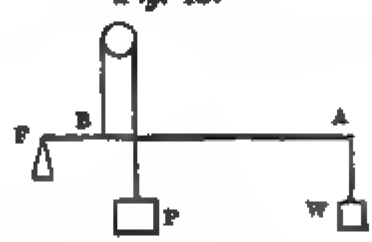
Such is an oar, or a handspike as used in "pointing" a gun. (*Fig.* 42.)

Fig. 42.



When the force is between the fulcrum and the weight, the lever is of the third order. (*Fig.* 43.)

Fig. 43.



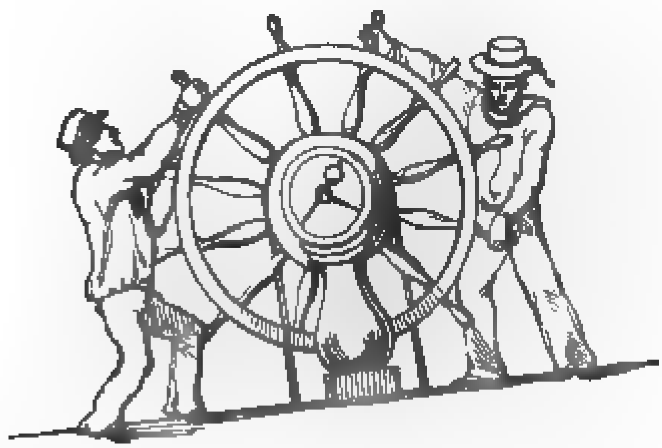
Such is the foot-board of a turning lathe.

The steering wheel acts as a lever both of the first and second order. (*Fig.* 44.)

"Of whatever kind the lever may be, the conditions of equilibrium of the power and weight will be such that they are inversely as their distances from the fulcrum, this being the general condition of equilibrium for all machines which turn round a fixed axis. It follows, therefore, that in the above figures *we shall have* $P : W :: FA : FB$; or, if p express the distance

of the power from the fulcrum, and w the distance of the weight from the fulcrum, we shall have $P : W :: w : p$, or, which is the same, $P \times p = W \times w$.

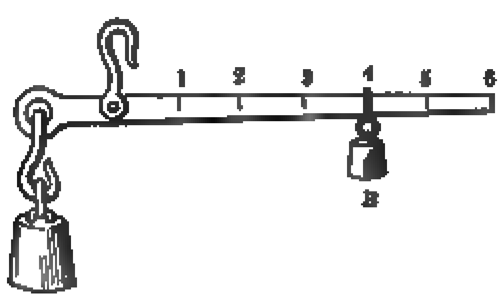
Fig. 44.



"This statement is a repetition of the general principle affecting machines which turn on an axis, in virtue of which, forces upon them are in equilibrium, when their moments round the axle are equal. The moment of the power is $P \times p$, and the moment of the weight is $W \times w$. The tendency of the power to turn the lever round its fulcrum in the direction of the power, is expressed by the moment $P \times p$, and the tendency of the weight to turn the lever in the contrary direction is expressed by $W \times w$."*

The distance of the force from the fulcrum is called its Leverage; and the effects of force will be proportional to its leverage. Thus, if we remove the force to double its distance from the fulcrum, its effect will be doubled; or to half its distance, we shall diminish its effect to one half.

Fig. 45.



* *Hand-book of* Natural Philosophy. Engineers' Pocket Book.

If we suppose the hook of the short arm of the figure to be one inch from the centre of support, x a pound weight on the long arm will always balance as many pounds suspended at the short arm, as the pound is removed inches from the fulcrum, supposing it to be slung horizontal; thus in the figure 1 balances 4.

To ascertain the proportionate length of leverage necessary to support a weight in equilibrium with a lever of the first order, divide the weight to be raised by the force to be applied, and the quotient will be the required proportion. For instance:—Required the proportionate length of leverage to balance a weight of 3 tons, with a force equal to 12 cwt? Then 3 tons = 60 cwt. $\frac{60}{12} = 5$. Here the long arm is 5, and the short 1, inches, feet, or yards, as the case may be, and an additional pound will raise the weight. But, although this is effected by a force of only one fifth of the weight, no "power" is gained, for the weight passes through only one fifth of the space which the force does. The products, therefore, arising from the multiplication of the respective weights and velocities are the same.

Example 2. — A weight of 1 ton is to be balanced with a lever 8 feet in length, by a force of 4 cwt.; required at what part of the lever the fulcrum must be placed?

$\frac{20 \text{ cwt.}}{4 \text{ cwt.}} = 5$; that is, the weight is to the power as 5 to 1; therefore, $\frac{8}{5+1} = 1\frac{1}{3}$ foot, from the weight.

Example 3. — A weight of 40 pounds is placed 1 foot from the fulcrum of a lever: required the power to balance the same when the length of the lever on the other side of the fulcrum is 5 feet? $\frac{40 \times 1}{5} = 8$ pounds — Answer.

(2.) When the fulcrum is at one extremity of the lever, and the force at the other, let this rule be adopted: As the length of the lever is to the distance between the weight and the fulcrum, so is the weight to the force.

Example 1. — Required the force necessary to balance 120 pounds, when the weight is placed 6 feet from the force, and two feet from the fulcrum.

As 8 : 2 :: 120 : 30 — Answer.

Example 2. — A *beam 20 feet* in length, and supported at

both ends, bears a weight of 2 tons at the distance of 8 feet from one end, required the weight on each support. $\frac{40 \text{ cwt} \times 8 \text{ feet}}{20 \text{ feet}} =$ 16 cwt on the support that is furthest from the weight; and $\frac{40 \times 12}{20 \text{ feet}} =$ 24 cwt. on the support nearest to the weight.

This lever shows the reason why two men carrying a burthen (as a cask upon a pole) between them may bear unequal shares of weight in reference to their strength. If the pole were 8 feet long, and the cask 1 cwt., placed in the centre, each man will bear 56 pounds; but if placed 5 times nearer one man than the other, the former will bear 5 times as much as the latter. Or if the men were 12 feet apart; the cask being 240 pounds, and 4 feet from the first man, he will sustain twice as much as the other: the first carrying 160 pounds, and the second 80 pounds, for $160 \times 4 = 80 \times 8$.

(3.) When the weight to be raised is at one end of the lever, the fulcrum at the other, and the force is applied between them.

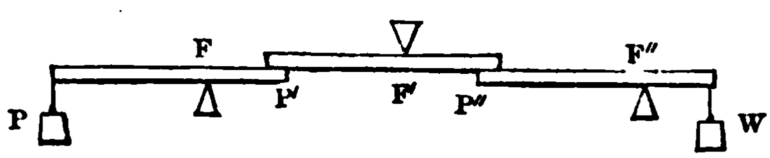
Rule.—As the distance between the force and the fulcrum is to the length of the lever, so is the weight to the force.

Example.—The length of the lever being 8 feet, and the weight at its extremity 60 pounds, required the force to be applied 6 feet from the fulcrum to balance it.

As 6 : 8 :: 60 : 80 pounds.—Answer.

"A combination consisting of several levers acting one upon another, as represented in the figure, is called a Compound lever.

Fig. 46.



"The force at P produces an upward pressure at P', which bears to P the same proportion as P' F to P F. Therefore, the effect at P', is as many times the force as the line P F is of P' F. Thus, if P F be ten times P' F, the upward pressure at P' is ten times the force. The arm P' F' of the second lever is pressed upwards by a force equal to ten times that at P. In the same manner this may be shown to produce an effect at P'' as many times *greater* than P' as P' F' is greater than P'' F''.

"*Thus, if* P' F' *be* twelve times P'' F'', the effect at P'' will be

twelve times that of P'. But this last, was ten times the force, and therefore P'' will be 120 times the force. In the same manner, it may be shown that the weight W is as many times greater than the effect at P'', as $P''\ F''$ is greater than $W\ F''$. If $P''\ F''$ be five times $W\ F''$, the weight will be five times the effect at P''. But this effect is 120 times the force, and therefore the weight would be 600 times the force.

"In the same manner, the effect of any compound system of levers may be ascertained by taking the proportion of the weight to the force on each lever separately, and multiplying these numbers together.

"In the above example, these proportions are 10, 12, and 5, which, multiplied together, give 600. The levers are of the first kind; but the principles of the calculation will not be altered if they be of the second or third, or some be of one kind and some of another."*

WHEEL AND AXLE.

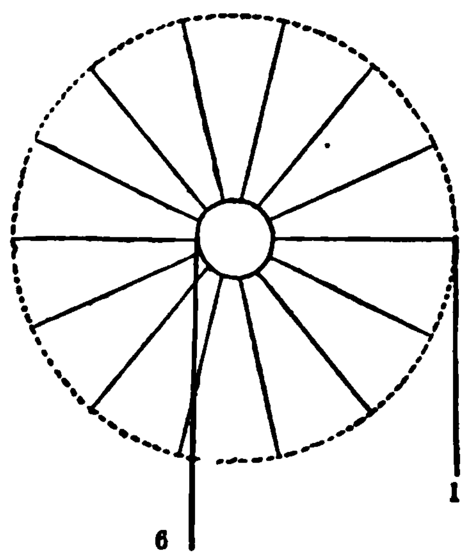
Whatever advantage may be gained by the combined action of lever upon lever, their applications involve so many inconveniences as to render such contrivances unfit for many purposes. The same results are however obtained by the *Wheel and axle*, which acts as a revolving lever, imparting a continuous, instead of an intermittent motion; economising space, and possessing the same mechanical properties as the straight lever. For the radius of the wheel is the long arm of the lever, and that of the axle, the short one: the centre of the axle being the fulcrum.† Moreover the circumferences of different circles bear the same proportion to each other, as their respective diameters do; consequently the advantage gained is in proportion as the circumference or diameter of the wheel is greater than that of the axle, and when the force acting on the circumference of the wheel is to the weight, as the radius of the axle (or barrel) is to that of the wheel (say spoke or capstan bar), the force and weight will

* Hand-Book, Philosophy.

† This will serve to explain the connection between short tillers and small barrelled steering wheels; as well as show the objection to cutting capstan bars for the sake of convenience in stowage, or on account of their length interfering with guns or bulk*heads*.

be balanced. If the semi-diameter of the wheel in the figure be six times greater than that of the barrel, the weight or resistance

Fig. 47.



will be balanced by a force of one sixth of its amount. But what is gained in force is lost in time, for the force must move through six times the space as the weight, and the weight rise or move slower in proportion.

In the *Capstan*, the axle is placed vertically, the wheel, or levers, or bars, moving horizontally: and its power is to be estimated just as above mentioned. Its great utility consists in its position, enabling us to apply force at every lever at the same time.

Let *fig.* 47. be a capstan, the semi-diameter of whose barrel is 2 feet, the bars, 14 in number, being 14 feet long. We have here a simple machine; and by applying any of the motive powers to the extremity of its bar or bars, that power is made to operate with seven-fold effect.

The force or useful effect of a man performing work by thrusting at the height of the chest is 30 pounds. Hence, if we place one man at the end of each bar, we have the means of sustaining a weight or resistance which is equal to 2940 pounds.*

If the weight or resistance were greater than 7 times the power, we must either put on more hands or more machinery. The main-yard, for instance, is 5 tons; but if we reeve five parts of jeers, a power of 1 ton on the fall would balance it. If we take the fall to the capstan, 420 pounds, or the force of

* *By the term* "useful effect" is meant the degree of force which a man *or brute can maintain* throughout a working day.

14 men at the bar ends, would balance it, and if we add 14 more men, they could raise it with ease.

It may often be difficult if not impossible to compute the amount of weight or resistance that we have to contend with; but we are always able to calculate the amount of our moving power, and it may be useful to know how to do so. Say that we place 5 men at each bar, we have then a physical force equal to 2100 pounds; but we must no longer consider the machine as one affording a seven-fold advantage; for, giving each man 2 feet elbow room, the leverage of the outside circle of men would be as 7 to 1; the second would be as 6; the third as 5; the fourth as 4; and the fifth as 3 to 1. Now, to ascertain the total amount of this combination of manual force and mechanical power, we may either multiply the former by the mean of the leverage, or multiply the force of each circle of men by their respective leverages.*

Leverages	7	Number of men	70
„	6	Force of each	30 pounds
„	5		——
„	4		2100 pounds
„	3		5
	—		——
„	5)25		10500 pounds
	—		
Mean	5		

or

$420 \times 7 = 2940$ pounds
$420 \times 6 = 2520$ pounds
$420 \times 5 = 2100$ pounds
$420 \times 4 = 1680$ pounds
$420 \times 3 = 1260$ pounds

10500 pounds

Thus we see that with such a capstan 70 men may move a weight of about 4½ tons, connected with the barrel by a single

* In the event of placing an extra hand at each swifter, their force, 2940 lbs., must be added to these results; or in using the second mode of calculation, the force of the *outer circle of hands may be* counted as $840 \times 7 = 5880$.

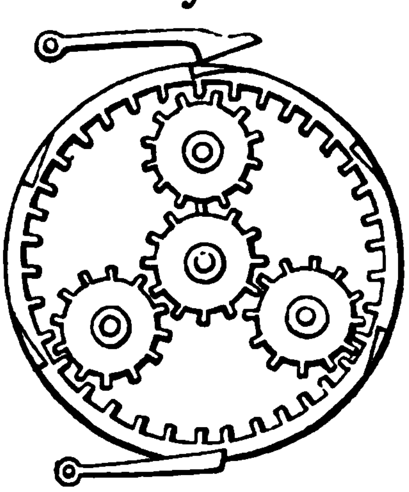
rope or chain, a task which would require the force of 350 men to accomplish if unaided by machinery.

But in the capstan, as in other machines, there are disadvantages as well as advantages; for in moving the weight (say 12 feet) the capstan must make one round turn, and the 70 men must exert their force through an average space of 60 feet and 60 units of time; whereas the 350 men in moving the weight 12 feet, would only exert their force through that space and a similar number of units of time. In the first of these cases, force is economised at the expense of time and space. In the latter, time and space are gained, but force is expended.

It should be observed that while an equal share of work fell on each of the 350 men, the inside men at the bars carried the weight of their bodies through 36 feet, and the outside men theirs through 84 feet, so that in long heaves we should frequently "change rounds." *

In the Patent Capstan, the drum-head is connected with the barrel by moveable bolts, and when these are down, the whole machine revolves together as in the case of one of common construction; but when greater power is required, the bolts are withdrawn, and the wheel-work shown in the figure (*fig.* 48.) is thrown into gear. The leaves on the spindle act on cog wheels, which act upon an *annular* wheel on the barrel; the spindle and barrel revolve in opposite directions, the former making 1 turn whilst the latter makes 3, affording a gain of 3 to 1.

Fig. 48.



By means of cogs or teeth, the axle of one wheel is brought

* In thrusting, as at the capstan, it is the muscular force more than the individual weight which tells, especially when the drum is placed high, and the men are short; as is evident from the attitude. Some French ships have thicker drums, and 2 tier of bars, on the lower of which the shorter men are stationed; so that the force is not only well to the full extent of the lever, but suitably arranged as to height.

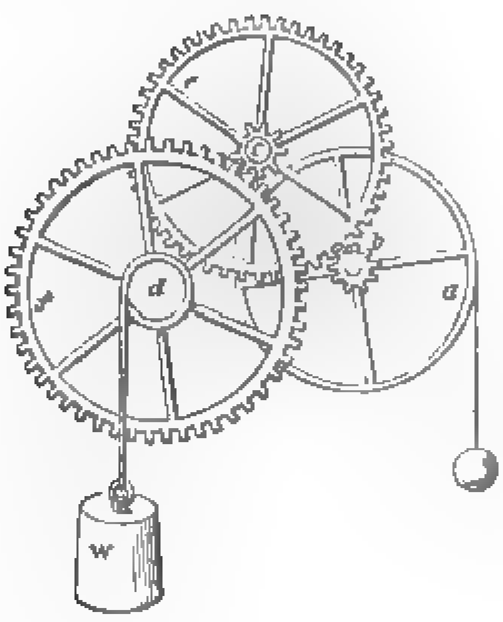
One power, so important as to deserve the name of a prime mover, must *not be forgotten*, and that is the fiddler; but for work which is intermittent, *such as anchor* work, to be a good one, he must have graduated at the *Bars*, *else he will* not understand how to keep step, or modify and excite pace.

to bear on the circumference of another on the same principle as that which obtains in a combination of levers, and the conditions of equilibrium are also similar.

The convenience of this combination will be comprehended by bearing in mind that if, for example, we want to raise or move a weight through the space of 100 feet with as small an exertion of force as 1 pound, that force must move through a space of 100 feet, by whatever kind of machine we may employ. Now it is more convenient to describe 50 circles of 2 feet in circumference with the arm, than to make one great vertical stroke of a lever of 100 feet, or move round a circle 100 feet in circumference with a horizontal one. Such a combination of wheels is called a Train. The cogs on the surface of the wheels are usually called *teeth*; those on the axle, *leaves*; and the axle having leaves, the *pinion*. When arranged, as in *fig.* 49., the power is said to be Concentrated.

If the diameter of all the axles be multiplied together, and also that of all the wheels be multiplied together, then the power

Fig. 49.



will be to the weight as the product of the axles is to that of the wheels. Or the conditions of equilibrium may be obtained by multiplying *together the number* of teeth on all the wheels,

and the number on all the pinions, the power being on the weight as the product of the latter is to the former.*

Leaves on the axle *b* of the first wheel *a* act on teeth on the circumference of the second wheel *e* ; and as there are six times as many teeth as there are leaves, *e* is turned once for every six turns of *a*. In the same manner *e*, in turning six times, turns *f* once; therefore, the first wheel turns 36 times for one turn of the last; and as the diameter of *a* (to which the power is applied) is 3 times as great as that of the axle *d* (which has the resistance), three times 36, or 108, is the difference of intensity between weights or forces that will balance here.

When great velocity is required, the circumference of a large cog wheel is made to act on that of the axle or rim of a smaller one, in which case the power is said to be Diffused. Were there 48 teeth on the rim of the larger wheel and 16 on the smaller, one revolution of the former would produce three of the latter, and in a train thus arranged, it is evident that the wheel farthest from the force would move with the greatest rapidity. The extent of motion that can thus be obtained, may be comprehended by studying the number of revolutions made by the second hands of a watch, or those of a driving wheel when used with the propeller shaft.

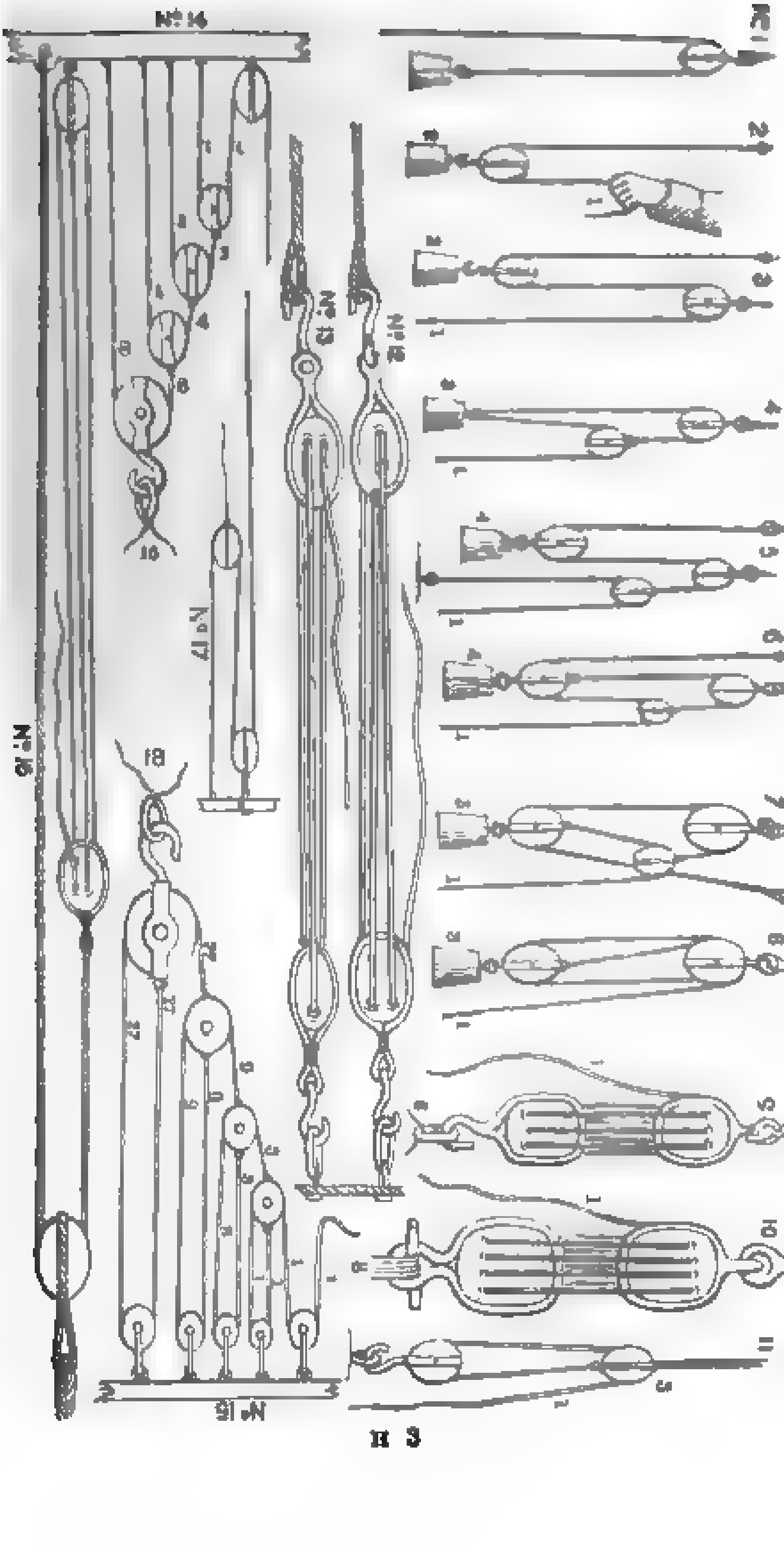
TACKLES.

Tackles (*fig.* 50.) are named according to the number of Blocks employed; and the arrangement and size of gear. The rope rove is the *Fall*; the part made fast, the *Standing part*: and the part hauled on, the running part, or end, or frequently also the fall.

Small tackles are usually called Jiggers; larger ones Bartons; still larger, Luffs; a heavy tackle or combination of such is a Purchase. A rope rove through a single fixed block is a Whip, as in *fig.* 50. No. 1. Rove through a single moveable block, a Double whip: this on a large scale is a Runner, as in Nos. 2. and 16. Rove through two single blocks, the upper one being fixed, a double whip, as in No. 3. Rove through two single blocks, the upper one being moveable, a Gun-tackle purchase, as in No. 11.

* Arnott's Physics.

Fig. 50.



Rove through a double and single block, the standing part being fast to the single block, a Luff-tackle, as in Nos. 8. 12, 13. Rove through two doubles, the standing part being fast to one of them, a Twofold Purchase, as in No. 6. Rove through two threefold blocks, the standing part being fast to one of them, a Threefold Purchase, as in No. 9. Rove through two fourfold blocks, the standing part being fast to one of them, a Fourfold Purchase, as in No. 10.

Combinations of tackles may be made variously; thus: No. 5. is a Whip upon whip. No. 16. is a Runner and tackle. Nos. 4. 6, 7. 14, 15. are Spanish Bartons. The increased advantage is found by multiplying their respective advantages into each other.

The general rule for ascertaining the power necessary to raise a weight with a tackle, is to divide the weight by twice the number of sheaves in the lower block, the quotient being the answer. Thus, in a threefold purchase, a power of 20 cwt. would balance a weight of 6 tons (friction not considered), but this only applies to particular reeves. Perhaps the theory of tackles will be best understood thus:—In No. 2. the strain is equally distributed between each part of the rope; and there being two parts employed in sustaining the weight, it is balanced by an exertion of power equal to one half of its weight; and the same principle applies to tackles of all kinds. Reeving the fall, as in No. 3., merely gives a more convenient lead; for the blocks which are fixed afford no mechanical advantage.

LIST OF TACKLES.—*Fig.* 50.

No. 1. Whip.
2. Double Whip.
3. Ditto.
4. Whip upon Whip.
5. Double ditto.
6. Spanish Barton.
7. Ditto.
8. Luff-tackle.
9. Treble.
10. Fourfold.
No. 11. Gun tackle purchase.
12. Luff, single block to the weight.
13. Ditto, double block to the weight.
14. Spanish Barton 16 to 1.
15. Ditto 81 to 1.
16. Runner and tackle.
17. Signal halyard downhaul.

The figures on the falls, in the engraving, denote the advan*tage; thus, in No. 5. it* is 4 to 1; in No. 14. 16 to 1.

The "Establishment" of spare disposable tackles of a ship are —

Four runners and tackles, with their respective lashing blocks. Four long tackles, the double blocks having a lashing eye. Two mizen burtons.

Four yard tackles; and, as there are great numbers of fitted blocks and spare ends of coils, any number of luffs may be rove when requisite.

It must be observed that too much attention cannot be paid to the maxim, that fixed blocks give no gain, for tackles admit of different applications. For instance, in No. 1. there is merely a lead; whereas in the runner in Nos. 16. and 2. with the same reeve of rope, but having a moveable block, a resistance of a certain amount would be overcome by about one half of its amount. Also in Nos. 12. and 8. the advantage is 3 to 1; whereas in 13. with the same kind of tackle it is 4 to 1.

In tackles, as in other machines, there is no increase of "Power;" for—the mechanical effects produced by any machine being measured by the work done in a given *time*, or by the *product* of the force exerted, and the *distance* gone through in a unit of time, in the direction of that force—whatever is gained in force is lost in time; and whatever is gained in time, is lost in force.* The convenience of a machine consists in enabling a small force working by a succession of efforts through a great space to raise a great weight, or to overcome a great resistance through a small space.

The ascent of a weight attached to a tackle is as many times less than the descent of the force as the weight itself is greater than the power; thus, in a twofold purchase the force being one, and the weight 4 cwt., and it being required to raise the weight 1 foot, each part of the rope must be shortened 1 foot, and the force descend through 4 feet.

One man may be able, with a tackle having 10 plies of rope, to raise a weight which it would require 10 men to raise at once, without a tackle. But if the weight is to be raised a yard, the 10 men will raise it, by pulling at a single rope, and walking 1

* Thus, the answering pendant is easily but slowly hauled down by one boy. Put a moveable block on the bight, as in No. 17., and to *run away* with it we shall require several boys. In the first case we economise force, but spend time; in the *latter, we expend force* but gain velocity.

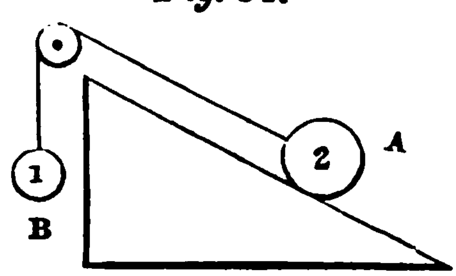
yard, while the single man at his tackle must walk until he has shortened the 10 plies of rope of 1 yard each ; that is, he must walk 10 yards, or ten times as far as the 10 men did. In both cases, therefore, we have just the same quantity of man's work used to accomplish the same end ; in the one case performed by 10 men in 1 minute, and in the other by 1 man in 10 minutes ; and if the work continues longer, say a whole day for 10 men, it will last 10 days for the single man : there is, therefore, no saving of labour from using tackles, *but a loss*, because of the friction. The same is true of all other machines ; none of them save labour, but they allow a small force to take its time to produce any requisite magnitude of effect. The real advantages of machines are, that a man's effort, or any single power, — as for instance, a capstan, — which is always at command, by working proportionately longer, will answer the purpose of the sudden effort of many men, even of thousands, whom it might be most inconvenient, or expensive, or even impossible to bring together.*

From all this, it may be observed, that when the resistance or weight is great, it may generally be overcome by a judicious arrangement of force ; and that when machinery can be dispensed with, direct *handling* is the quickest of all modes for moving weights.

INCLINED PLANE.

The Inclined Plane acts as a mechanical power by sustaining a portion of the weight which is being raised by its assistance. When the power acts in a direction parallel to the slope (*fig.* 51.), and is to the weight as the height of the plane is to the slope, the power and weight will be balanced ; but when the power is applied in a direction parallel to the base, it will only be to the weight as the weight is to the *base*. In *fig.* 51. the plane is twice as long as it is high, and 1 pound at B balances 2 at A. If the plane were inclined to the horizon one-third of its

Fig. 51.



* Arnott's Physics.

whole length, a body could be kept from rolling down it by a force equal to a third part of the weight of the body.

Examples. — If a plane be 6 feet high, and with a slope of 15 feet, what weight will 150 lbs. sustain?

As 6 : 15 :: 150 : 375. — Answer.

It is required to raise a field-piece or cask, &c., weighing 1000 lbs., to a boat's gunwale, or a cart, or bank, &c., which is 5 feet high, with a plane formed of *skids* 14 feet long; what force must be exerted to prevent either of these weights from rolling down?

As 14 : 5 :: 1000 lbs. : 357¼ lbs.—Answer.

If a rope be passed round the weight, one end being fast, and the other hauled on, it would be a *Parbuckle*, and would afford the same advantage as is shown in the tackle marked 2.

WEDGE.

When two bodies are forced from one another by means of a wedge, in a direction parallel to its back.

Rule.—As the length of the wedge is to half its back or head, so is the resistance to the power.

Example.—The breadth of the back or head being 3 inches, and the length of either of its inclined sides 10 inches, required the force necessary to separate 2 substances with a force of 150 lbs.

As 10 : 1½ :: 150 : 22½ lbs.—Answer.

When only one of the bodies is moveable.

Rule.—As the length of the wedge is to its back or head, so is the resistance to the power.

Example.—The breadth, length, and force, the same as in the last example.

As 10 : 3 :: 150 : 45 lbs. — Answer.

SCREW.

The Screw is a cord wound in a spiral direction round the periphery of a cylinder, and is, therefore, an inclined plane, the length being the circumference of the cylinder, and the height

the distance between two consecutive cords or threads of the screw. Hence, the nearer the spirals are to one another, so much greater is the force of the screw.

Rule.— As the circumference of the screw is to the distance between the threads, so is the weight to the power.

Example. — The circumference of a screw being 8 inches, and its pitch, or distance between the threads, 1 inch, required the power to raise 648 pounds ?

As 8 : 1 :: 648 : 81 pounds.— Answer.

When a winch or lever is applied to turn the screw, the power of the screw is as the circle described by the handle of the winch, or lever, to the interval or distance between the spirals.

The different powers — the lever, wheel, tackle, and screw — admit of various combinations, and, when combined, form what is called a compound machine. Thus we have in a ship the lever acting on wheel, as in the side lever or sway beam of the engine acting on the paddle, and as in the patent capstan; wheel upon lever, as in the steering gear; tackle upon lever, as in the compressor; and wheel upon tackle, as in the capstan or winch.

The Crane is a familiar machine, and the mechanical advantage of it may be generally determined by finding that of each

Fig. 52.

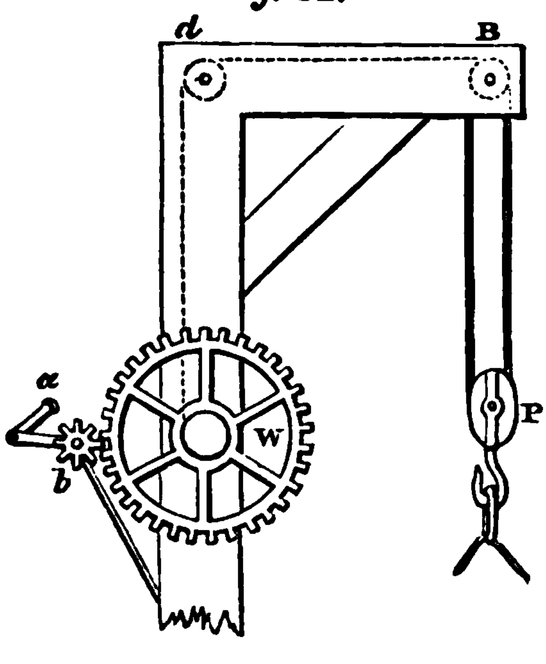
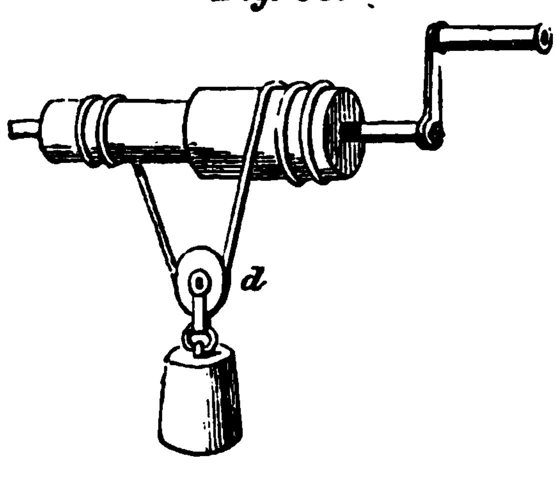


Fig. 53.



part separately. Let the radius of the handle *a* (*fig.* 52.) be six *times that of* the pinion *b*; the radius of the wheel w ten times

that of its axle round which the fall is passed, and a power of 30 pounds be exerted; then as the threefold tackle is 6 to 1, we have $30 \times 6 \times 10 \times 6 = 10{,}800$ pounds: a weight which might be raised by a force equal to 30 pounds.

The Compound Wheel and axle (*fig.* 53.) is of Chinese origin. It differs from others, inasmuch as with the common kind power is gained only by increasing the wheel and diminishing the axle; whilst, with this contrivance, the less difference there be between the diameters of the two cylinders the greater will be the power. As the rope unwinds from the small, it is taken up by the larger one, and is shortened at each turn by the difference of the circumferences. "If the weight rises $\frac{1}{2}$ an inch only, while the handle of the winch describes a circle of 50 inches, 1 pound force at the winch will balance 100 pounds at D."* It is evident the uncoiling rope acts in favour of the handle.

FRICTION.

Friction may be defined to be that which interferes with one surface moving freely over another, and depends conjointly on the inequalities of those surfaces, and the force of pressure upon them.

Friction is independent of the extent of the surfaces in contact, or of the velocity with which they move upon each other.

The surfaces being of the same nature, a double pressure will produce a double amount of friction; a treble pressure, a treble amount, and so on. Friction is increased by time: thus, it requires the application of a greater force to move a weight along a horizontal plane from its position of rest, than to keep it afterwards moving on the same plane.

Friction is greater in cases where the fibres of two moving bodies are parallel, than when those of one are at right angles to those of another. It is also greater when the natures of the bodies are different, than when similar; and it is always greater with soft, and less with hard substances.

The friction of hard metals against hard is estimated at $\frac{1}{6}$; whilst that of softer, such as tin upon tin, is about $\frac{1}{4}$ of the pressure. By the employment of unguents, the irregularities are filled up,

* *Arnott's Physics.*

or the surfaces somewhat separated, and friction is diminished.* Thus, to drag a square stone of 1080 pounds weight along the floor of a quarry, required a force of 758 pounds ; over a floor of planks, 652 pounds; placed on a frame of wood and dragged over planks, 606 pounds. After soaping the woodwork, 182 pounds; placed on rollers 3 inches in diameter, and dragged along the floor of the quarry, 34 pounds. Thus placed and dragged over planks, 28 pounds; and on interposing the rollers, 22 pounds.†

When a weight hangs by a tackle at rest, all the parts of the fall bear an equal strain, and the weight will be balanced by one at the end of the fall as many times less as there are parts of the rope at the block to which the larger weight is suspended. But directly the fall is hauled upon, this is no longer the case. In consequence of friction, there will not be an equal strain on all parts of the rope ; and it becomes necessary in calculating the practical power of the tackle, not (as before) to multiply the force by the number of parts of rope at the moving block, but to find the strain or tension on each part, and add all together.

To do this exactly, is extremely difficult, if not impossible ; as the different tensions of the parts depend upon so many varying circumstances. Such, for instance, as the flexibility of the rope, which differs according to its size, newness, dryness, and material: the relation of the diameter of the sheaves to that of the pin ; the material of these and their condition, upon all which the amount of resistance caused by friction depends. All we can do is to give some rough rule which may be to some extent practically useful.

If A B D (*fig.* 54.) be the sheave of a block turning from A by B to D, C being the centre of the pin, then the friction will act at the point E in the direction E F, and with a leverage E C. This will have to be overcome by the fall acting along D G, with leverage C D. The longer therefore C D is in proportion to E C, the easier will the resistance by friction be overcome ; consequently, the

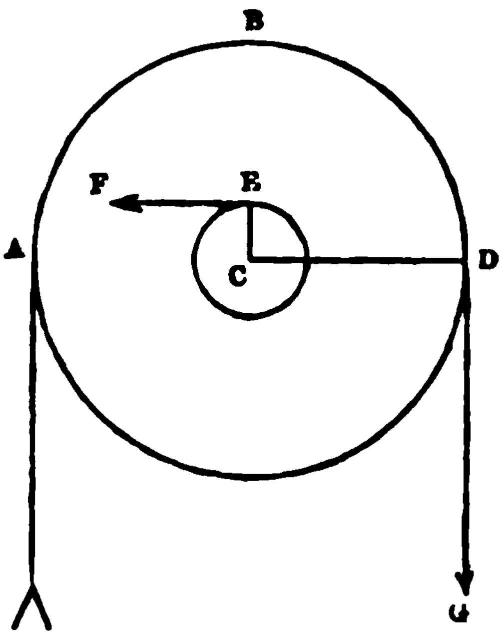
* In the case of most machines ⅓ of the pressure is a fair estimate of the friction.

† *Large* round shot, when confined by strong grooved "*ways*," form efficient and convenient rollers.

pins being the same, the greater the diameter of the sheave, the easier the block will work.

The same rule applies to the capstan as well as the

Fig. 54.



block. The longer the bar, the more easily will the resistance of the friction on the spindle be overcome.*

If the rope which passes round the sheave of the block be small, it will be more flexible; a less force will be necessary to "nip" it round the pin, and there will be less resistance by friction against the inside of the shell of the block.

Perhaps we shall not be far wrong in ordinary cases if we estimate one sixth of the original force to be consumed by friction each time that the rope passes round a sheave. Thus, supposing the tension or strain on the hauling part to be 6, that on the next

* "The loss by friction is less as the bars are longer, or as power is applied at a greater distance from the axis. It is least of all when the pressures are so distributed *round* the capstan as to be reducible to a 'couple.' The case in which the moving pressures upon the capstan are reducible to a couple manifestly occurs when they are arranged round it in any number of pairs, the two pressures of each pair being equal to one another, acting on opposite sides of the centre, and perpendicular to the same line passing through it. This symmetrical distribution of the pressures about the axis of the capstan is therefore the most favourable to the working of it, as well as to the stability of the shaft which sustains the pressure upon it."— *Moseley's Mechanics*.

will be 5, the next 4, the next 3, and so on. So that if the strain on the fall of a two-fold tackle be 6, the tensions or strains on the parts of the rope will be represented by the figures 6, 5, 4, 3, and their sum 18 will nearly represent the power of the tackle instead of 24, which it would have been had there been no friction ; or about one fourth of the force would have been consumed by it.

Suppose a weight of 24 to be suspended by the above tackle. If the fall would just bear a weight of 6, the four parts would be sufficient to suspend the weight; but if it were required to raise it, we must have a rope at least one third stronger; or equal to sustain a weight of 8. The tensions would be, according to the above rule — 8, $6\frac{2}{3}$, $5\frac{1}{3}$ and 4, and their sum will be 24, which is what we require to lift.

From these considerations we gather, that work is lightened by using large blocks and small ropes ; that the Boatswains' rule, that the hauling part of a fall bears double the strain of the standing part, is not far wrong ; that as the pin of a block is more worn on one of its sides, it should be frequently turned; and that as sheaves nearest the standing part do least duty, they should be shifted occasionally with the others.

CHAP. VIII.

THE TELESCOPE.

To comprehend the general principles on which the Achromatic Telescope is constructed, it will be necessary to understand certain facts respecting the composition and effects of Light.

"Vision or Sight is produced by the rays of light, which fall from the sun (or other source of light) on an object ; being reflected from thence, so as to fall upon the retina or back part of the eye ; thus, the moon is seen by the rays of light which *fall on it* from the sun, being reflected back to the eye ; and a *tree or house*, or any other object is seen by the daylight which

falls on the tree or house, being in like manner reflected on the eye." *

Transparent bodies of various forms are called Lenses, and rays of light passing through any lens undergo certain changes in their direction, according to its form and density. Thus, the tendency of a convex lens is to concentrate parallel rays passing through it, and bring them all to one point or focus; whereas that of a concave lens is to disperse them, by throwing them more apart from each other. The density of the lens, or transparent medium, effects similar changes; a ray passing from a rarer to a denser medium, as from air into water, or glass, is said to be refracted, or bent from its straight direction – an effect, which may be observed in the bent appearance of an oar when dipped in the water. A set of rays diverging from any point is called a *Pencil of rays*; the central ones being called its Axis.

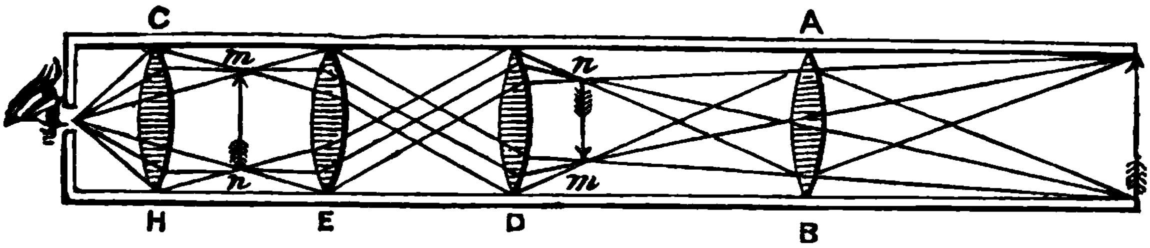
The distance of the focus of a double lens equally convex on both sides is equal to the radius of the curve. From the nature of a convex lens the axis of each pencil will pass straight through the lens, but its other rays will be collected on the axis in a focal line, at a distance beyond the lens equal to its radius. If all light be excluded except that which passes through the lens, and a screen be placed at the focal distance, the rays from the object will present an inverted image of it on the screen.

It may be said, in passing, that this is what takes place in the human eye. Its principal apparatus is a double convex lens, called the crystalline humour, which is protected by a transparent coat called the cornea. Between these, and surrounding the crystalline humour, is a membrane, the iris, having a circular hole called the pupil, furnished with a muscular provision, by which its openings may be enlarged or diminished. In the back part of the eye, is an expanded network of nerves (the retina), which is connected with the brain by means of the optic nerve. The visual rays from the object pass through the pupil to the convex lens, which produces their inverted image on the retina, whence the optic nerve communicates their impression to the brain.

* Bell's Bridgewater Treatise.

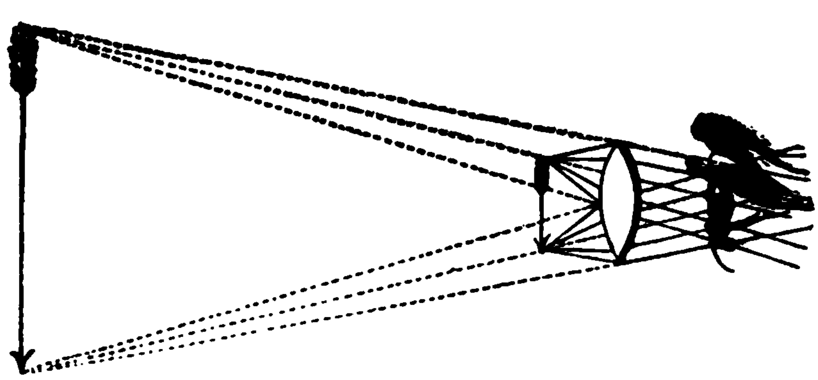
An inverted image being formed in the tube of the telescope by the object glass A B, at *n m* (*fig.* 55.), is presented in the natural position of the object by means of the different refractive powers of other lenses at *m n*, where it is viewed by the eye-glass, G H. The use of the eye-glass is to cause the rays emerging from E F to converge sufficiently to focalise on the retina; and thus the image is not only as minutely examined as though the object were close, but, being magnified in proportion to the focal length of the lens, is distinctly visible in all its details. For it is a law in optics that we see everything in the direction of that line in

Fig. 55.



which the rays approach us last. Thus, for instance, in *fig.* 56. a parcel of rays is shown diverging from the extremities of the smaller arrow; which rays, being refracted by the lens, are re-

Fig. 56.

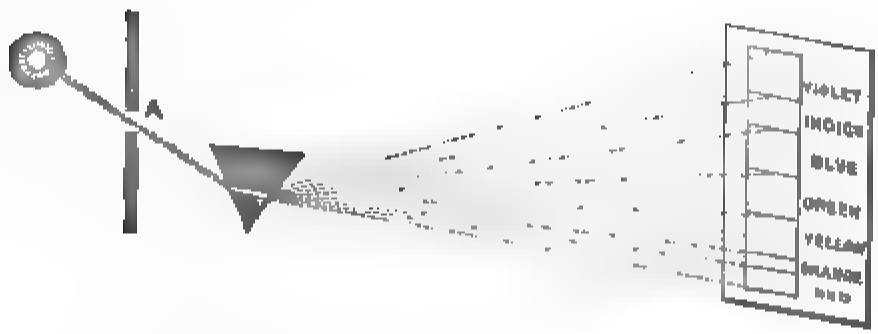


ceived in the eye precisely as if they emanated from the larger one.

Such, in general language, is the Refracting Telescope; but the term "achromatic" involves a few words on the *composition* of light as well as the *substance* of lenses. By darkening a room, and placing a glass prism in an aperture in the closed shutter, so that a ray of solar light will pass through it, it has been shown *that such* light is a compound of other lights, all of which have *different colours* and different degrees of refrangibility: and that

ı passing through transparent media, or lenses of unequal thick-
ess, it becomes decomposed. In this mode of analysing light,
ıe different rays are dispersed, and appear on the wall as in the

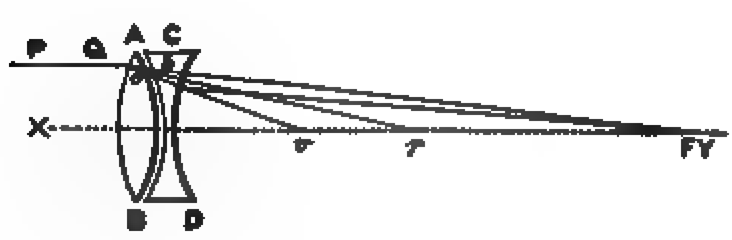
Fig. 57.



rder represented in *fig. 57.* Now, such being the com-
osition of light, and as lenses act more or less like prisms,
ispersing colour, it follows that the image of an object
ırmed by single lenses must, from this interference of colour,
e indistinct. This, opticians tried in vain to overcome, until it
'as discovered that, by composing and combining two or more
ases of different kinds of glass, each having different degrees
' dispersive power, and so forming them as to refract the rays
ı counteracting directions, this chromatic aberration could be
ımoved.* Thus—

The object glass of an achromatic (free of colour) telescope is

Fig. 58.



ɔmposed of a double convex lens of crown glass outside, and
ɔother of flint glass, double concave, inside.

* London Drawing Book. Our limit of space precludes the notice of the
ıperfections consequent on *spherical aberration.*

"By the refractive power of the convex crown glass lens (*fig.* 58.), the red rays in the pencil of light P Q would, if not interfered with, proceed in the direction Q *b*. But the refractive power of the concave flint glass lens, C D, acts from its form in a direction contrary to that of A B, causing the rays either to diverge from the axis, X Y, or to meet it in points beyond *v* and *r*, towards Y. Suppose the curvature of this lens to be such that the red rays in the pencil P Q would, after refraction in both lenses, meet the axis in F (the ray Q *b r* taking the direction *b* F), then the dispersive power of this kind of glass exceeding that of the other kind, the violet rays in the refracted pencil will tend farther away from the axis than the red rays do, and thus will tend towards the latter; the ray Q C *r* for example, taking the direction *c* F. It is conceivable, therefore, that the curvatures of the surfaces of the lenses may be such that, in each incident pencil, the red and violet rays (the extreme rays of the spectrum), shall after refraction unite at the place of the image: and that thus, the fringe due to these colours, may be destroyed. In uniting these rays, the others are brought so near together, that, for ordinary purposes, the image is as free from colour as can be desired." *

* National Encyclopedia.

CHAP. IX.

MASTS.

All the Spars of a ship are either of fir or pine. The smaller kinds are made when possible of one stick, and are then called *Single tree.* The larger are composed of several pieces, arranged in various manners, and united by scarphs, coaks, and iron-hooping; these are called *Made masts*, &c. (*Figs.* 59, 60.)

The Hoops of masts are either driven on whilst hot, or else, being made with hinges, are drawn tightly together by screws. Those of the latter kind are called Clasp Hoops.

The *Hoops* are covered on the fore part by a batten called the *Rubbing Paunch.*

The *Hounding* is the length of the mast from heel to the lower part of the head; the *Howsing* is the length from heel to upper deck.

The Hounds and Tressle trees which form the foundation for the tops; the *Chain Necklaces* to which the topmast rigging is to be secured; the *Bolsters* which are to preserve the eyes of the lower rigging from chafe; the Mast-head battens, the Bowsprit cap and the Boom irons, are all fixed in their places, before the spars are issued from the mast-house. The heels of the main-masts of screw ships are either made open for the passage of the screw shaft, or else fitted with a forked iron step in the form of an arch. Very recently, however, the main-mast has been stepped on the orlop deck.

That part of the bowsprit which rests upon the stem, is called the Bed; inside of that, the Howsing; and the outer part the Bee-seating or Head. The bowsprit cap is fastened on the bowsprit by an iron plate underneath, and this plate is secured by a bolt, which being driven through it and the bowsprit, is nutted on the upper side of that spar. All the other caps are moveable.

Top-masts are always made in one stick, the only addition being the Hounds, and the squaring pieces at the Fid-hole. Their half dumb sheave below the fid-hole, and the live sheave above it, are cut diagonally through the mast in opposite directions;

MADE MASTS.

Fig. 59.

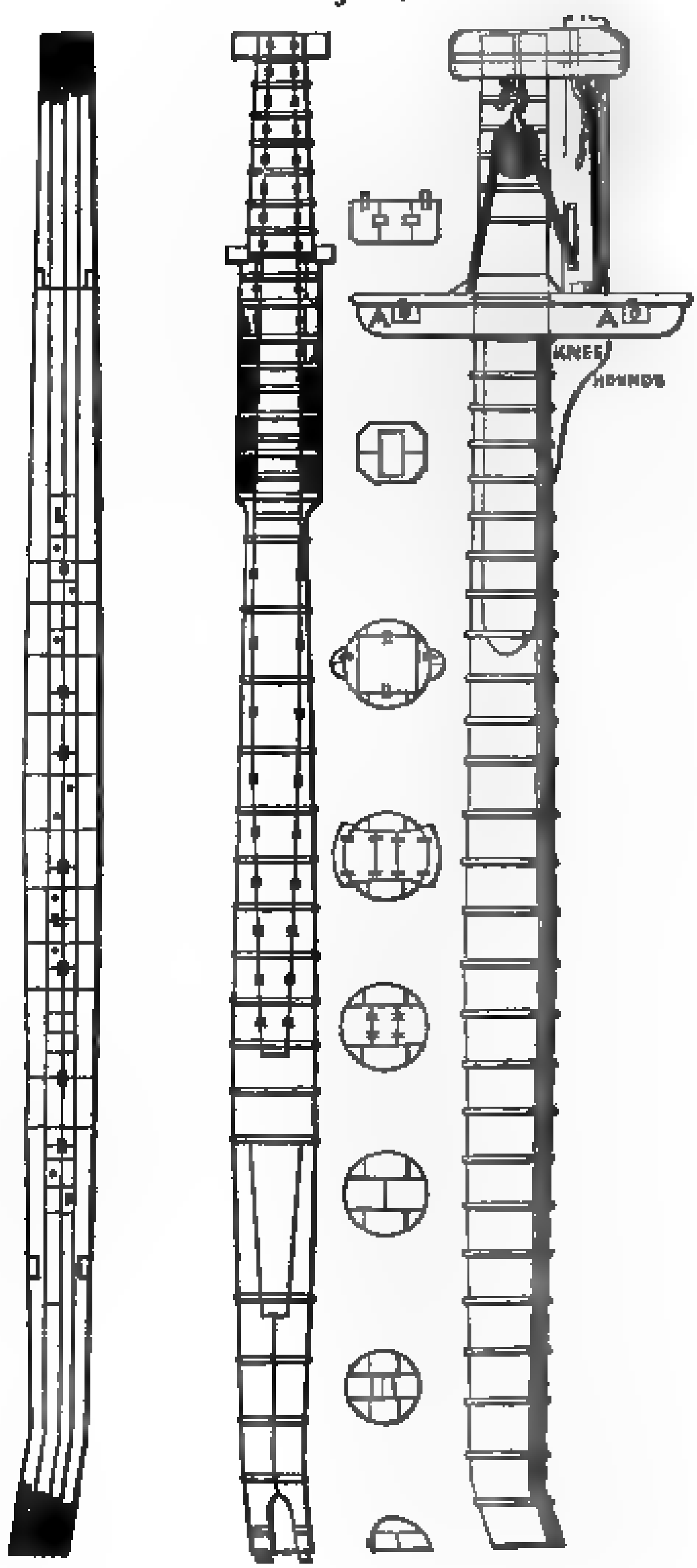
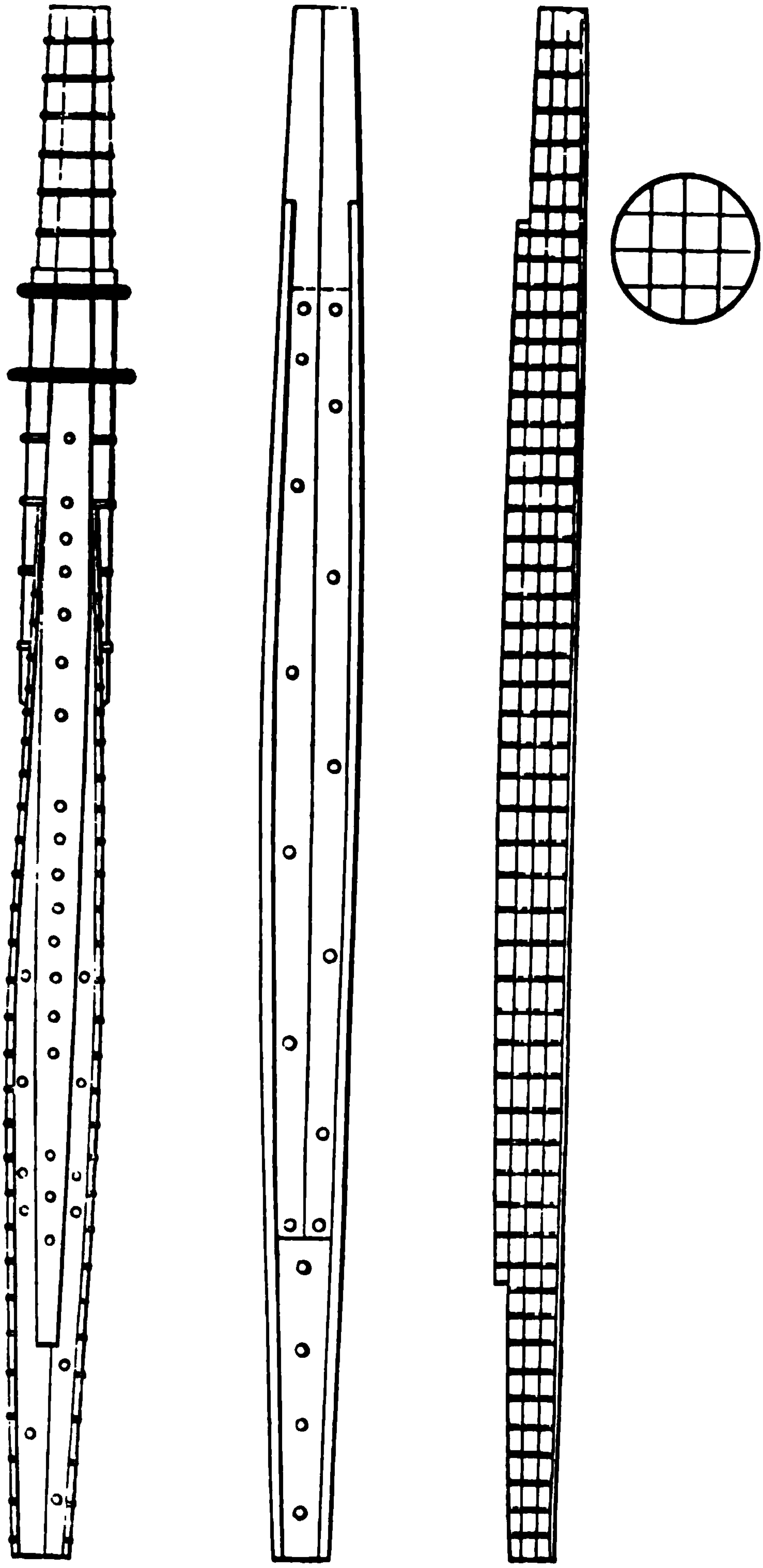
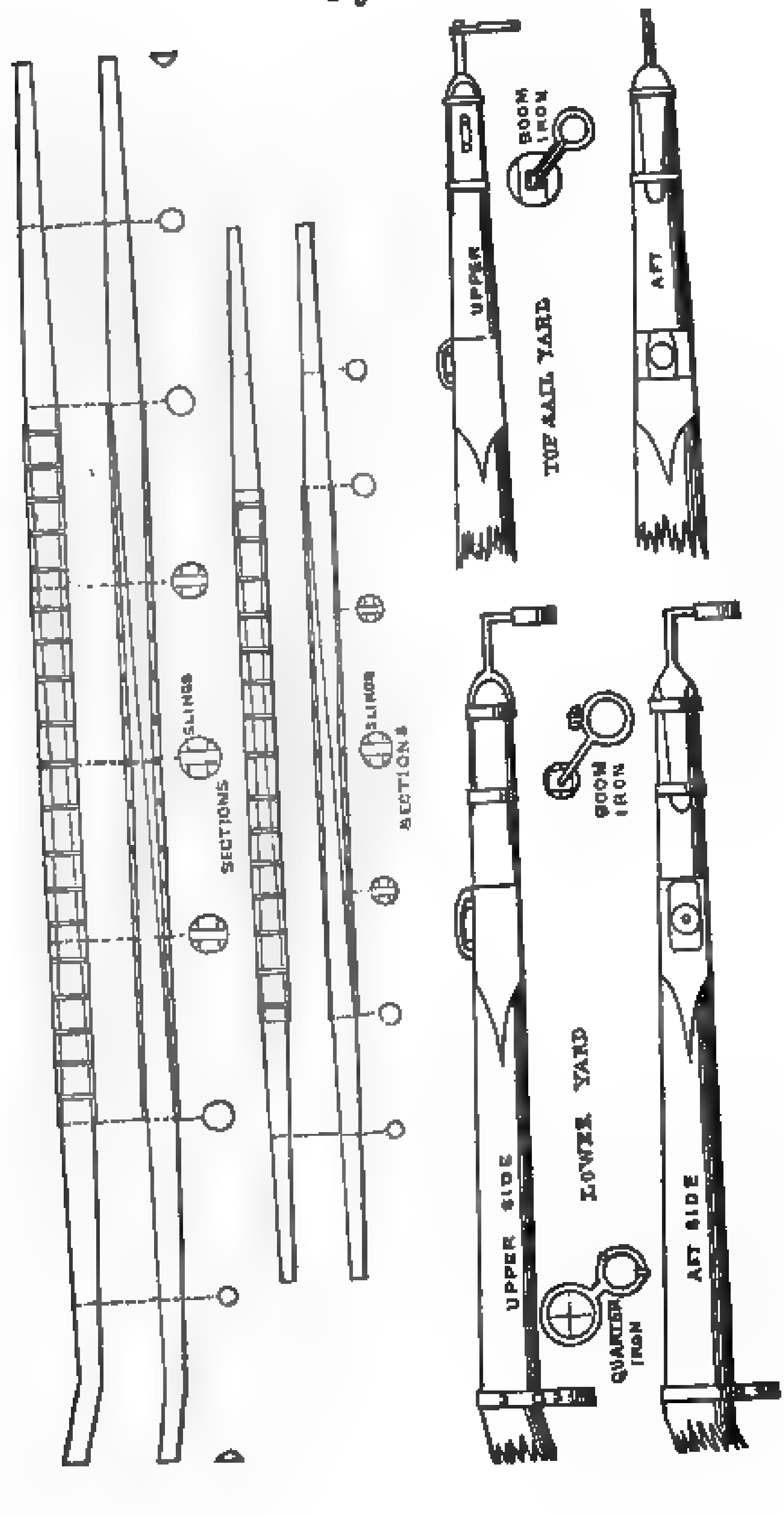


Fig. 60.



I 3

Fig. 61.


BOOM IRON
UPPER
AFT
TOP SAIL YARD
SLINGS
SECTIONS
SLINGS
SECTIONS
BOOM IRON
LOWER YARD
UPPER SIDE
AFT SIDE
QUARTER IRON

ıese are for the ropes (the top-tackle pendants) which are used striking or getting up the masts. In main-top-masts, the live ıeave is cut from the after eight square on the starboard side to .e foremost one on the port side. In fore-top-masts, it is cut om the after eight square on the port side to the foremost one ı the starboard side. This arrangement brings the working p-tackle fall on opposite sides of the deck.

Lower Caps were formerly made of elm, but now generally ' mahogany, bound with an iron hoop of one third of their ›pth.

The four *Eye-bolts* for the Top-blocks stand athwart ships on e lower side, and are clenched on top. The after ones are aced in a line with the middle of the mast head, the fore-ost ones in a line with the centre of the hole for the top mast.

Bowsprit Caps are fitted with eye-bolts for the heel chain of e jibboom.

Top-mast Caps have eye-bolts and generally a sheave on each de enclosed in the cap-band, which answers in lieu of a top-ock for the top-gallant-mast rope.

Yards are made eight square in the middle, and with a ıoulder left at the arms for the rigging. (*Fig.* 61.)

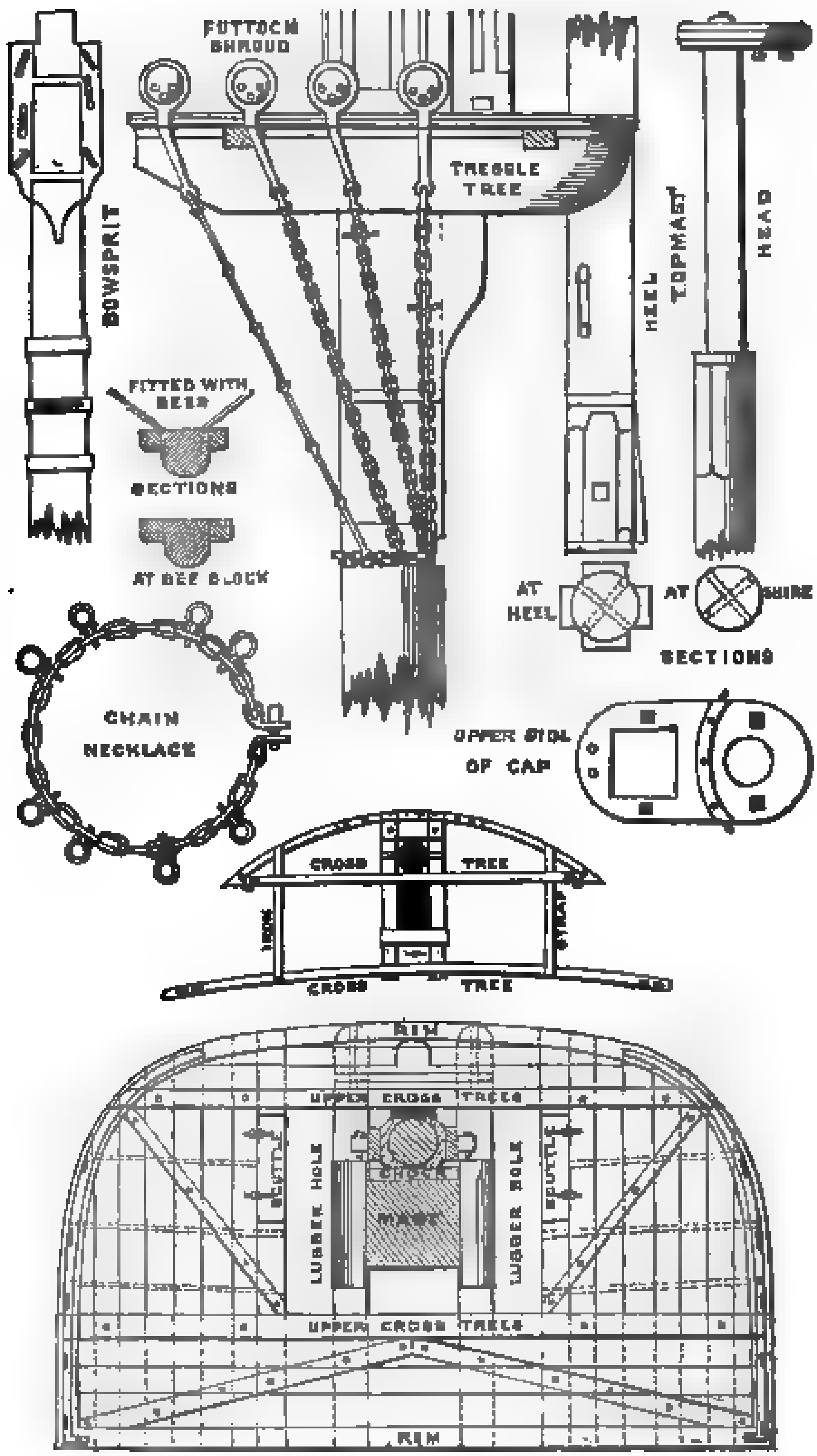
The *Quarter Irons* of lower yards open on hinges; the outer ıes are in one piece. Top-sail yards have no quarter irons, but e arm irons disconnect.

Lower and Top-sail Yards are iron-hooped, with a row of eye-›lts on the upper side for the "Jack-stay."

The *Lower Cross-Trees*, when in place, fit in scores on the ›ssle-trees, one abaft the lower mast-head, and the other before e hole for the heel of the top-mast. They are secured by saucer aded bolts, driven through, and nutted under the tressle-tree.

This is a most important fastening. In stripping ship, rpenters will be "drifting" and unclenching their bolts, if not rbidden. In a case where these bolts were started, the cross-›es were upset whilst the half-tops were being tripped, and tops, ›es, and the men on the mast-head fell, and were smashed on e deck. Some years afterwards, when paying off a line-of-ttle ship, these same bolts with others had "only just been ifted," in spite of a given warning, and the same consequences ›uld have followed, had not the danger been discovered in ne.

Fig. 62.


FUTTOCK SHROUD
TRESSLE TREE
BOWSPRIT
HEEL
TOPMAST
HEAD
FITTED WITH BEES
SECTIONS
AT BEE BLOCK
AT HEEL
AT SHIRE
SECTIONS
CHAIN NECKLACE
UPPER SIDE OF CAP
CROSS TREE
CROSS TREE
RIM
UPPER CROSS TREES
LUBBER HOLE
LUBBER HOLE
CHOCK
MAST
UPPER CROSS TREES
RIM

Tops are made both whole and in halves. They are strengthened by upper cross-trees, which stand immediately over the lower ones. The edges are fitted on each side with iron plates for the futtocks, and there is a lubber's hole hatch cut on each side of the centre. (*Fig.* 62.)

The *Top-mast Cross-Trees* are built and bolted into the tressle-trees, forming one fitment; the former, however, can be removed and replaced at pleasure. The bolsters also are nailed on over the necklace before issue.

Fids for top-masts are differently fitted. The common method is with an iron bar, thrust edge upwards through a corresponding hole in the heel of the mast, both ends resting on the tressle-trees. These should always be secured in the top with a strong lanyard; for sometimes when dragged out in striking top-masts in a gale, they are left lying on top of coils of wet rope, and are liable to be rolled out.

In some cases the hole in the top-mast is cut away upwards on one side, and downwards on the other, the fid pivots on a bolt on one side of the centre, and is thus made heaviest on the side of the downward cutting in the mast. The tressle also is cut away on that side; and the cutting is covered by the arm of an iron lever which, as it pivots on the tressle-tree, may be placed fore and aft, or athwart ships at pleasure.

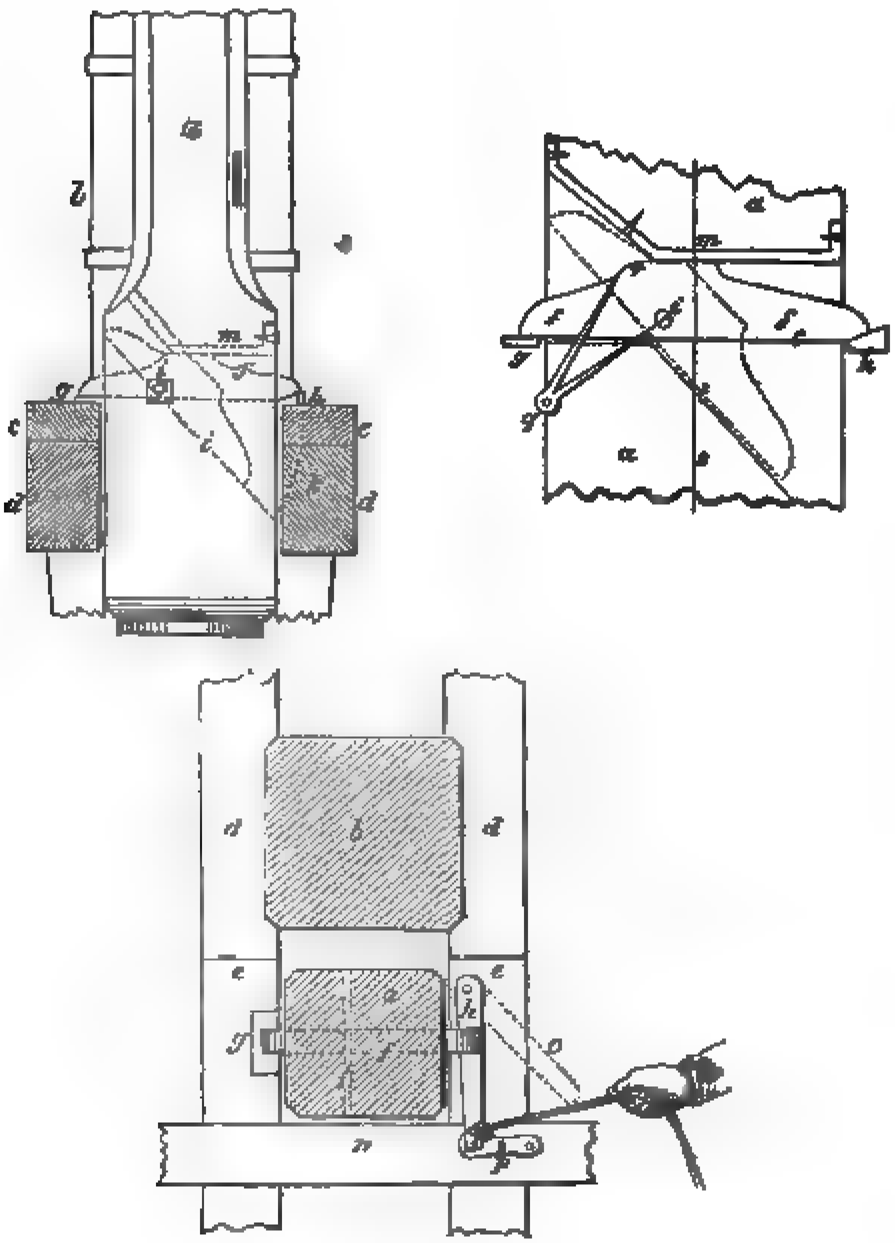
When the mast is fidded, the heaviest end and the fid rest on the lever, which is then lying along the top of the tressle-tree; the other end being borne by the opposite tressle-tree.

In striking, the Top Tackles are hauled well taut, the pin which secured the lever from moving is taken out, and a jigger on the lever end pulls it out from underneath the end of the fid; which then falling down through the cutting in the cross-tree stands aslant inside the heel of the mast, and admits of its being lowered. (*Fig.* 63.) In fidding, when the fid is squared, the lever is hauled in underneath, and is pinned as before. The advantage here is that masts may be struck without waiting to let go any gear; and also that the fid is more readily squared than the moveable one is handled.

The heels of *Top-gallant-Masts* are frequently cut open underneath the fid hole, so as to admit of snatching the bight of the mast rope in a sheave which is placed in the cutting. When there is length enough of heel, holes are bored below the sheave

and a bolt is rove through them, and *fore locked* whenever the rope is scored.

Fig. 63.



In some cases a mere catch is placed across the bottom of the cutting.

Both these fitments are intended to keep the rope in its place in the event of the lizard slipping off when the mast is moving.

Should it do so, the mast tilts over end, and if the fastening on the heel is strong enough, the rope brings it up. A bolt *is* strong enough: *a clamp is not.*

If the heel is too short for a bolt, put in two clump sheaves in lieu of one large one, and then there will be sufficient space.

Top-gallant Fids are of wood, in the form of wedges, which are pinned together when in place.

By cutting a lizard hole aslant through the mast, something more than the length of the top-mast head from the royal sheave hole, time will be gained in sending the top-gallant-mast up; for the royal rigging and royal-yard rope may be placed simultaneously with the casting off of the lizard: otherwise there must be two stoppages.

Average Value of Spars.

	Spars.	Three-decker. Value.	Two-decker. Value.	Large Frigates. Value.	Small Frigates. Value.
		£	£	£	£
Main.	Mast	430 to 473	333 to 432	256 to 334	88 to 248
	Top	100 — 117	96 — 117	66 — 96	32 — 61
	Top-gallant	16 — 21	16 — 21	11 — 16	7 — 11
	Yard	116 — 153	102 — 153	79 — 102	30 — 54
	Top-yard	40 — 44	38 — 44	32 — 38	15 — 29
Fore.	Mast	339 — 366	299 — 341	216 — 300	63 — 210
	Top-mast	91 — 107	91 — 107	62 — 91	30 — 60
	Top-gallant	12 — 16	11 — 16	8 — 10	5 — 8
	Yard	79 — 102	56 — 102	45 — 54	24 — 41
	Top-yard	32 — 38	29 — 38	25 — 29	11 — 21
Mizen.	Mast	99 — 100	79 — 99	60 — 84	37 — 59
	Top	41 — 48	38 — 48	26 — 38	13 — 26
	Top-gallant	7 — 9	7 — 8	6 — 7	4 — 7
	Yard	28 — 33	26 — 33	22 — 26	11 — 22
	Top-yard	17 — 23	15 — 23	13 — 15	8 — 13
Bowsprit		174 — 185	140 — 176	100 — 140	30 — 99
Jibboom		29 — 30	27 — 30	21 — 27	8 — 18
Spanker-boom		38 — 44	33 — 44	27 — 33	12 — 25

The following Tables of weight and dimensions of spars are taken from Mr. Edye's "Calculations;" but they do not include those of such great size as are now in use in the new class of first rates.

Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.
120	Foremast.	36	28	15	18	120	Mainmast.	39	32	20	2	120	Mizenmast.	27	8	5	8
84		35	0	15	12	84		39	32	20	0	84		27	8	5	6
74		32	30	10	4	74		36	0	14	6	74		24	23	3	16
60		32	30	10	18	60		36	0	14	6	60		25	16	6	1
50		30	6	9	7	50		33	6	12	16	50		24	0	3	11
46		27	18	6	4	46		30	0	7	18	46		21	25	2	9
26		26	24	6	2	26		29	12	7	16	26		20	25	2	8
28		21	18	2	9	28		23	24	3	2	28		16	0	1	9
18		19	33	2	13	18		22	27	3	9	18					
10		15	18	1	7	10		18	6	1	17	10					

Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.
120	Fore-yard.	30	13	3	15	120	Main-yard.	34	28	5	3	120	Cross-jack-yard.	24	20	1	7
84		29	33	3	15	84		34	15	5	3	84		24	27	1	7
74		28	4	2	15	74		32	8	4	4	74		23	18	1	1
60		28	4	2	15	60		32	8	4	4	60		23	18	1	1
50		28	4	2	15	50		32	28	4	4	50		23	18	1	1
46		25	29	1	16	46		27	9	2	10	46		19	24	0	13
26		23	19	1	16	36		26	34	2	10	26		19	24	0	13
28		18	12	0	15	28		21	0	1	1	28		15	18	0	6
18		18	6	0	12	18		18	7	0	12						
10		16	0	0	11	10		16	11	0	11						

Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.
120	Fore-top-mast.	20	34	2	6	120	Main-top-mast.	22	34	2	11	120	Mizen-top-mast.	16	17	0	17
84		20	26	2	6	84		23	0	2	11	84		16	28	0	17
74		19	8	2	2	74		21	22	2	6	74		15	32	0	15
60		19	8	2	2	60		21	22	2	6	60		15	32	0	15
50		19	8	2	2	50		21	22	2	6	50		15	32	0	15
46		15	34	1	4	46		18	0	1	8	46		13	24	0	9
26		15	10	1	4	26		18	0	1	8	26		13	18	0	9
28		12	26	0	11	28		14	14	0	12	28		10	29	0	5
18		12	6	0	10	18		12	35	0	11						
10		10	19	0	7	10		10	12	0	7						

Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Ship.	Spar.	Length. yds.	in.	Weight. tons.	cwt.
120	Fore-top-sail-yard.	21	18	1	0	120	Main top-sail-yard.	24	28	1	9	120	Mizen-top-sail-yard.	16	12	0	8
84		21	20	1	0	84		24	27	1	9	84		16	12	0	8
74		20	18	0	15	74		23	18	1	2	74		15	13	0	6
60		20	18	0	15	60		23	18	1	2	60		15	13	0	6
50		20	18	0	15	50		23	18	1	2	50		15	13	0	6
[illegible]		17	28	0	13	46		19	24	0	14	46		13	20	0	4
26		17	20	0	13	26		19	24	0	14	26		13	12	0	4
28		13	24	0	4	28		15	18	0	6	28		10	12	0	1
18		14	0	0	4	18		14	0	0	4						
10		12	18	0	4	10		12	18	0	4						

Guns.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Guns.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Guns.	Spar.	Length. yds.	in.	Weight. tons.	cwt.
120	Fore-top-gallant mast.	10	13	0	6	120	Main-top-gallant mast.	11	17	0	7	120	Mizen-top-gallant mast.	8	8	0	3
84		10	0	0	5	84		11	18	0	7	84		8	8	0	3
74		9	22	0	4	72		11	0	0	6	74		8	0	0	2
60		9	27	0	4	60		11	0	0	6	60		8	0	0	2
50		9	20	0	4	50		11	0	0	6	50		8	0	0	2
46		7	29	0	3	46		9	0	0	4	46		6	30	0	2
26		7	30	0	3	26		9	0	0	4	26		6	27	0	2
24		6	13	0	1	24		7	7	0	2	24		5	16	0	1
18		6	22	0	1	18		8	23	0	2						
10		6	15	0	1	10		6	18	0	1						

Guns.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Guns.	Spar.	Length. yds.	in.	Weight. tons.	cwt.	Guns.	Spar.	Length. yds.	in.	Weight. tons.	cwt.
120	Bowsprit.	20	1	11	2	120	Jibboom.	17	18	1	1	120	Driver-boom.	23	7	1	2
84		20	25	11	0	84		18	24	1	1	84		23	13½	1	2
74		22	0	8	8	74		16	0	0	17	74		22	27	0	17
60		20	0	8	8	60		16	0	0	17	60		22	27	0	17
50		21	18	8	8	50		16	0	0	17	50		22	7	0	17
46		18	6	4	19	46		13	8	0	10	46		18	21	0	15
26		18	4	4	17	26		12	1	0	10	26		19	12	0	15
20		14	31	2	1	20		11	0	0	5	24		14	20	0	8
18		14	16	1	13	18		9	0	0	3	18		19	12	0	19
10		12	0	1	1	10		9	0	0	2	10		16	23	0	10

MASTING.

Ships are "masted" by sheers rigged either on the Dock sides, on a hulk, or from their own resources.

To rig small sheers. Two spars of about equal length and strength are placed side by side, having their heels near the place where it is desirable they should stand, and a lashing is passed round the heads, which becomes tautened when the heels are separated. The heels are lashed so as to prevent them from sliding from their place; the working tackle and guys are secured over the head lashing; the heads are lifted off the ground, and the sheers uprighted by the guys.

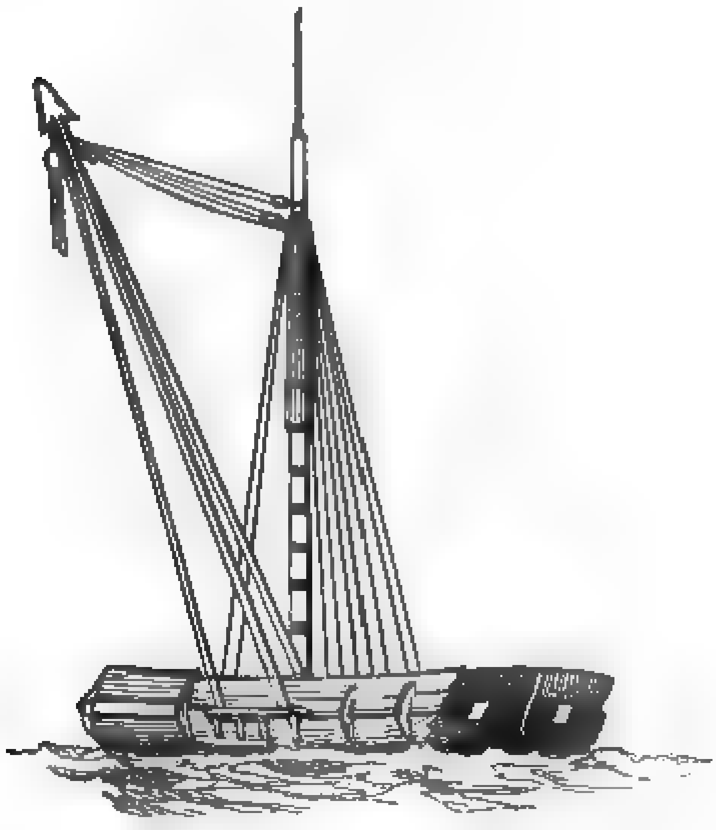
To get up a heavy pair, the process would be similar, excepting that the tackle would be used in uprighting, and the heads would be lifted to a certain height by a small pair.

Large Sheers on the margin of sea walls are got up after securing the heels on shore, by lifting the heads with a tackle from the mast head of a vessel moored in front, and the aid of a small pair raised at their heels.

In Hulks *the heels of the sheers* are stepped on a stool built on

the side; the heads are borne off by a spar (a spur), stepped against the mast at the deck, and supported by guys and tackles from the mast head. The mast is purposely built, and of great strength, and the vessel is counter ballasted. (*Fig.* 64.)

Fig. 64.

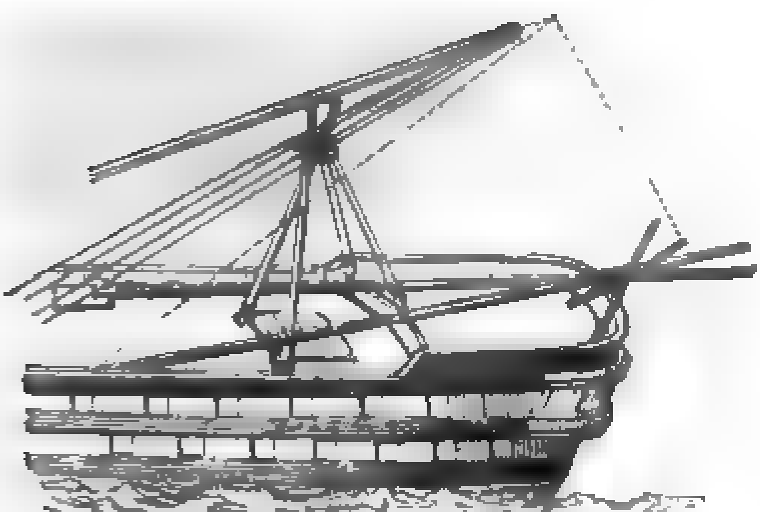


In places where there are no regular masting establishments, the process of *fitting a sheer hulk*, and *masting* a *ship* would be so similar that one description will answer for both.

Small spars are hung over the side as Fenders. Suitable sheer spars being brought alongside, are either parbuckled, or hoisted by Derricks to the upper deck, largest ends forward, and placed with their small ends crossing on the taffrail. A lashing is passed round these small ends, over which the two purchase blocks, gantline blocks, and fore and aft guys are secured. The heels of the sheers are placed at the sides, nearly abreast the mast hole, on chocks of hard wood, and after being cleated, are lashed forward and aft, through the adjoining ports. The deck is

shored up underneath. The purchase and fore guys are carried as far forward as possible, the falls being taken to the capstan. If the sheers are very large, additional guys — belly guys — are put on half-way up the sheer legs. A small pair of sheers are raised inside the large ones, about half way aft, their heads drooping rather aft. Tackles are led from these to each leg of the large sheers, somewhat abaft the line of the heels of the small ones. The fore guys of these small ones must of course be strong. Runners and tackles are best. The large sheers are raised to a certain height by the tackles from the small sheer heads. A pull on the runners lifts them still higher, and then the main purchase does the rest. (*Figs.* 65, 66.)

Fig. 65.

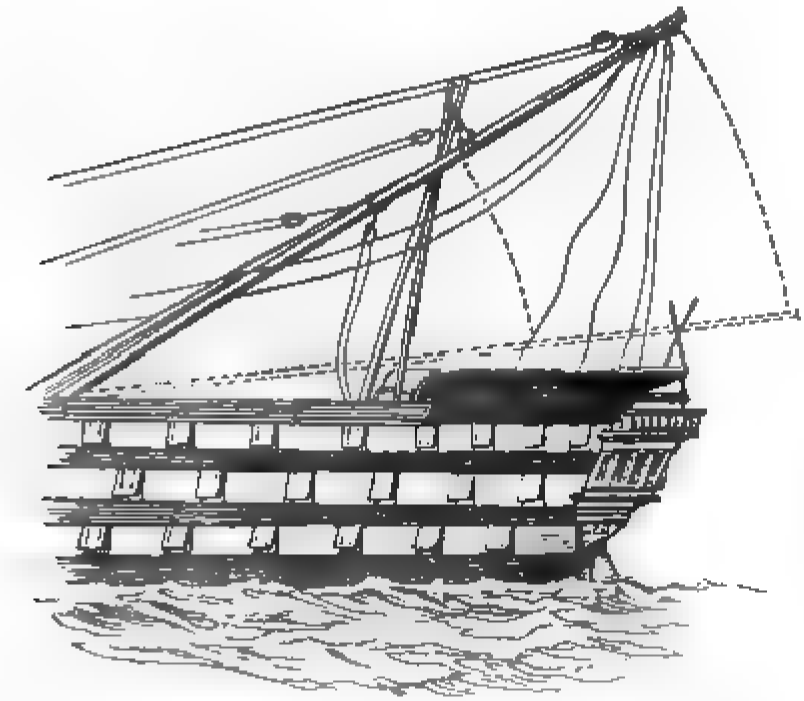


The Mast Strops, which are warped ones, are lashed on the masts before launching. To these, the lower purchase blocks are toggled ; gantlines are put on the mast heads ; and the mast being hove up into an upright position over the deck, the heel is directed into the partners, and lowered into its Step. It is usual to take a mast in or out on that side on which the after-mast sheer-leg stands.

In the case of a ship, the sheers are moved forward or aft by deck tackles, the guys being carefully attended at the same time. In getting the bowsprit in, the sheers are drooped over the bows plumb out to the length of the howsing.

In all cases of drooping, extra lashings are put on the heels *from* the direction to which the sheers droop.

Fig. 66.

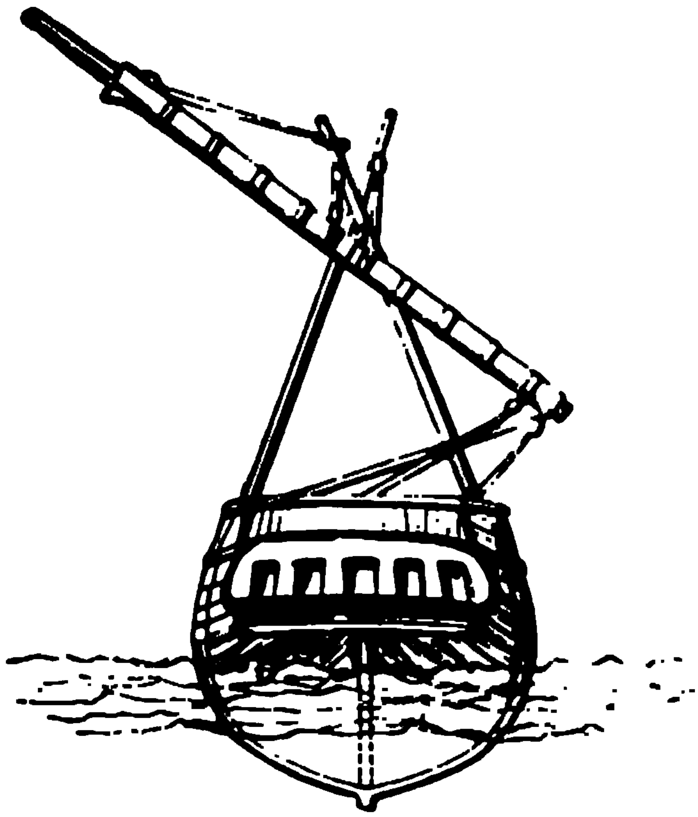


The Masting Spars are got down by lashing their heads separately to the lower mast, casting their cross-lashing off, and lowering them down by tackles which are triced up by the gantlines.

In Masting or Dismasting with one's own resources, it is necessary to measure the lengths for slinging the masts very accurately, so as to make sure of carrying the heel clear of the upper deck, and yet avoid, if possible, top-heaviness. When the spars are short for the work (as in the case of the top-masts of a high ship), the masts must be slung so low as to make top-heaviness unavoidable. In going out, when the heel of the mast is near the upper-deck partners, tackles are put on above from each side of the upper deck, and a particularly strong and long one, led from below through the lower mast holes, is lashed to the heel, and well cleated each way. These tackles are tautened, *until* when, the heel being clear of the partners, they are eased *away, and the* mast lowered head foremost overboard.

In coming in, the Mast is slung above the balancing point and hoisted up with an extra tackle alongside the sheers; the

Fig. 67.

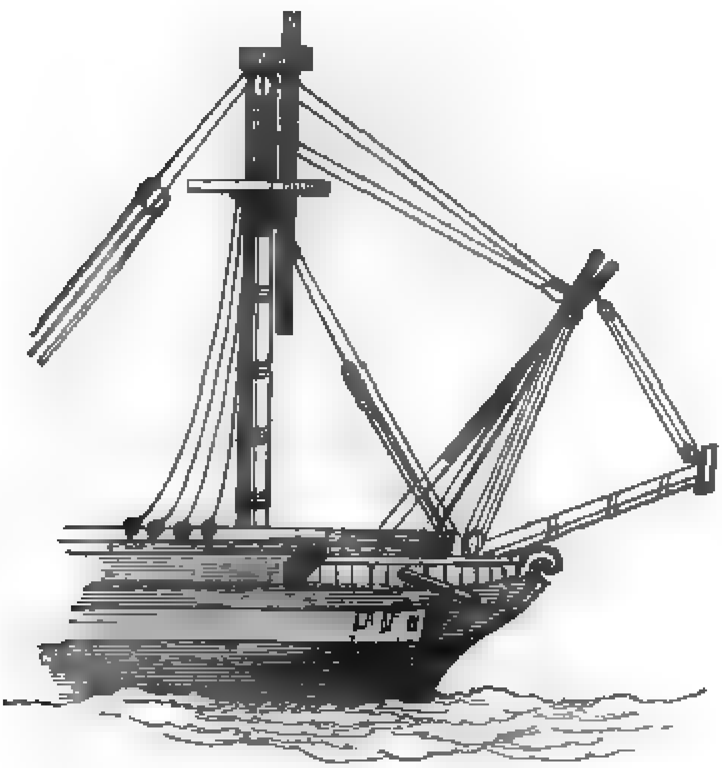


purchases are then lashed low enough down, and the heel is confined to the side by the turns of a greased hawser passed through the ports; or, in a merchant ship, through the ballast-hole. When the heel is nearly up to the highest bight, deck-tackles are lashed on from all sides, which are cleated in their place. These are tautened as the mast rises, and guy the heel, when high enough, into the mast-hole.

In handling a *Bowsprit* with our own resources, the fore-top-mast is of course struck, and the fore-mast secured with runners and tackles. Hang the heel of the top-mast with a hawser, and unreeve the ends of the pendants from the top-mast; unhook the top tackles, send the eyes of the pendants down abaft the top, hook on the top-tackles, carry them aft, and lash the lower blocks to the skids; if not long enough, tail the falls with the main ones. Place the spare fore and main-top masts with their heads across the forecastle netting, and lash them together their heels being on each side of the fore-mast: on the upper side of these mast heads, lash the two main-top blocks, and on

the lower a threefold purchase block. Send the points of the fore-top pendants down *over* the fore-top, reeve them through the top blocks on the spars, and make the ends fast to the fore-mast head.* Reeve a fall through the purchase block; upright the spars with the long tackles, led from the fore-mast pendants; secure the heels to the side; shore the deck underneath; lash well from forward; droop with the top tackles, until the heads overlook as far from the fore side of the hole as the length of howsing; lash the lower purchase block a little more than half way out on the bowsprit, and put a long tackle from the sheer heads to the

Fig. 68.

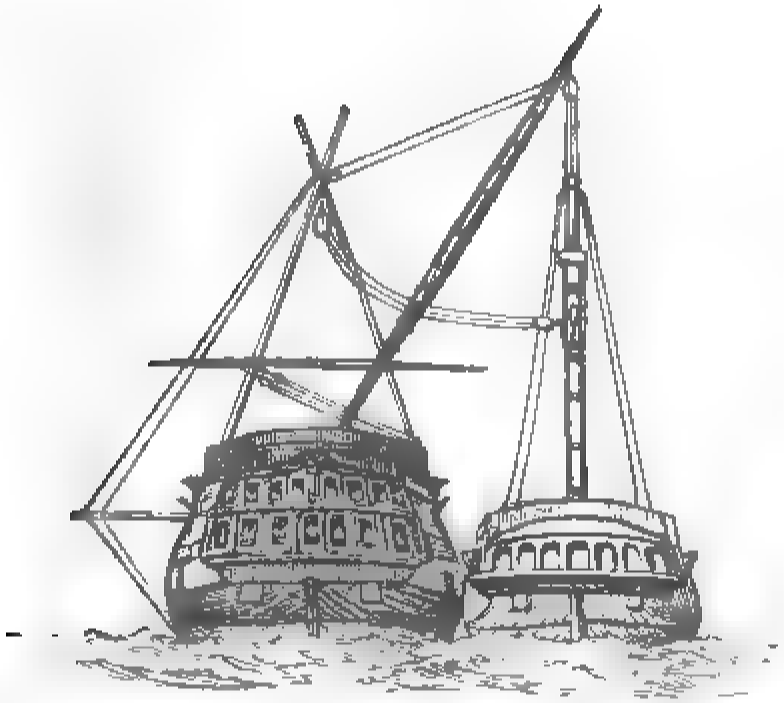


bowsprit cap. Let the bowsprit come up, or hang athwart ships when suspended, so as to clear the figure head; top or lower, to liking, with the top tackles. The purchase fall should lead to the deck in a line with the sheers.

* The pendants probably will not admit of being doubled until the sheers are raised by the long tackle.

A neat performance in the history of *Masting* on one's own resources was in the case of an English line-of-battle ship, which, having lost her own main-mast, helped herself in one operation to that of a captured frigate. Sheers were formed of the main top-masts, whose heads were supported by guys set up to the fore top-masts which were rigged out through the main-deck ports on the off-side. A Derrick was made of the main yard, which was secured at its lower quarter to the sheer leg on the working side, the pressure at this point being relieved by an athwart ship spar, thrusting outwards by means of a tackle led across the deck. The purchase on the upper arm of the derrick took the mast out, the frigate was dropt astern, the mast lowered until the sheer purchase "looked" well up and down, when that tackle brought it in.*

Fig. 69.



Besides carrying duplicates of all spars, except the lower ones, ships are supplied with wooden and iron Fishes. The former

* When, in dismasting, a mast is jammed in the step, a gentle roll given to the ship will start it.

are nearly long enough to reach from the deck to the lower mast hounds; the latter are about 18 feet long, and are invaluable articles. There are also rough spars of different sizes, as well as spare anchor stocks, and large oak planks, all of which are available for jury rigging in emergency.

When a *Lower Mast* is sprung or wounded below the head, it is supported by runners and tackles, the fish are placed up and down, and lashed round the mast by *wooldings* which are set taut by wedging. If the head is sprung, the top-mast is struck, the heel hung by a top chain, chocks are placed between the masts, and wooldings passed round all. (*Fig.* 70.)

Fig. 70.

Bowsprits and Lower Yards may be fished in several ways; and *altogether* replaced by a combination of ship's materials.

In all ships the main top-mast, driver boom, and mast fishes

are about the same length as the bowsprit: these, with two studding-sail booms, being woolded together form even more than its girth.

Top stud-booms are half the length of their yards, and with a top-sail yard and some small spars for filling pieces are readily "lashed up" into a good substitute for a lower yard.

The fore yard of the "Thetis" was carried away at the slings into two separate pieces. These were sent down, stript of the rigging, and battens placed straight along the deck, with their lower sides downwards, the ragged ends trimmed, and the fracture shut in by bowsing the pieces together with tackles on different sides. Two iron fish were then nailed on the fore-side of the middle, and the yard chocked steadily as it lay. The after part of the middle was then cut away in a form to receive a half-anchor stock, which was bolted through to the yard. One long fish, which had meanwhile been tapered and hollowed, was placed at the after side of the yard, shutting in the anchor stock, and nailed on. Chain straps were then passed round all in several places and set taut with iron wedges; between these the wooldings were hove on, and work having been commenced at 6 A.M., the yard was in its place and sail set on it by 5 P.M. The ship had meanwhile been turning to windward, a mizen top-sail having been set as a fore top-sail, and a reefed main top-sail bent to the spare main top-sail yard as a fore-sail. The hoops taken off the bunt of the yard were driven on the ends of the fish, and this yard did duty long after without showing a symptom of weakness. (*Fig.* 71.)

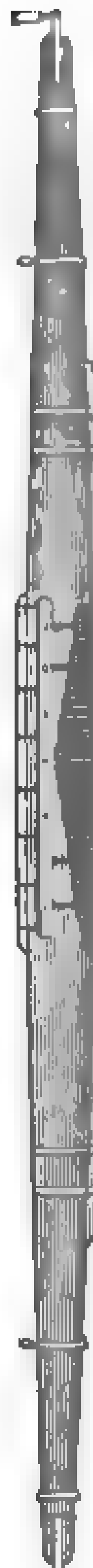


Fig. 71.

LIGHTNING CONDUCTORS

Were formerly made of wire rope or chain. It has, however, been proved that the electric-fluid will invariably select for itself the line of shortest conduction offered by the best conductors, either in buildings, ships, &c. For instance, in lowering the masts, the bights were frequently left hanging slack, and a seaman, happening to be in contact at the moment of action, became the shortest course.

They are now made of copper (which is the best of conductors) nailed on in double strips, about $1\frac{1}{2}$ inches wide and 4 feet long each, on the after side of masts and lower side of jib boom and bowsprits. The connection is formed at the caps by a hinged flap, which may be turned back whilst handling the spar, but should always be replaced. Each upper mast-head is adapted to receive a spindle which terminates the conductor at top, and the lower ends of the conductors are connected with bolts passing through the ship's bottom. Besides this there are similar strips of copper leading under the decks, from the fore and main masts to the stem and stern; and others which traverse the beams, and terminate also in bolts through the bottom, which are clenched on the sheathing.

When the top-gallant-masts are down, the spindle should be placed on the top-mast head.

CHAP. X.

EQUIPMENT.

RIGGING.

EXCEPTING the wheel ropes, which are usually of hide, all Rope used in the navy is hempen.

The size of rope is denoted by its circumference, and its nature by the manner of its fabrication. It is either white or tarred; contains three or more strands; and up to the size of five inch, is made up in Coils.

The hemp is first spun into *Yarns* or *Threads*, each of which is supposed to be equal in strength to bear a weight of 100 pounds.

Several yarns spun up together form *Strands*. Three or four strands laid up together form *Hawser-laid rope*. (*Figs.* 72, 73.)

Three such three-stranded ropes laid up together form Cable: the smaller kinds of which are called *Cablets* and *Hawsers*. 74.)

are spun up right handed. Strands intended for

right-handed rope are spun up left-handed; and those for left handed rope right-handed.

Fig. 73.

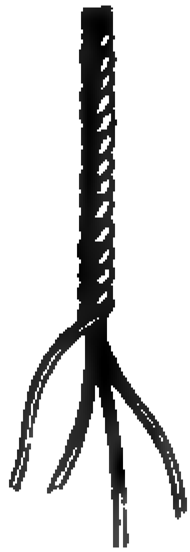


Fig. 72.

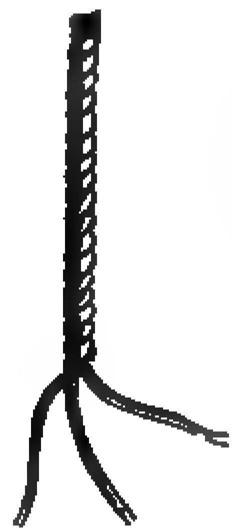
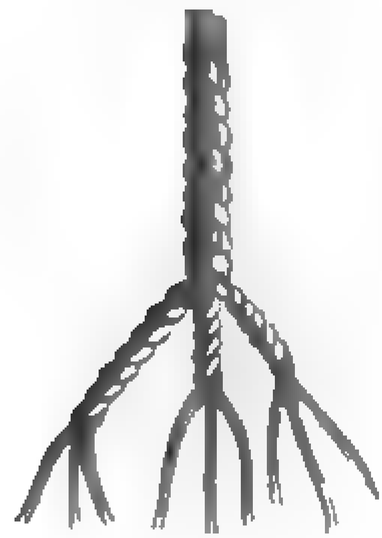


Fig. 74.



The large four-stranded hawser-laid rope which is made up round a small rope in the heart, being chiefly used for standing rigging, is commonly called *Shroud-laid rope.* The rope represented in the sketch *Figs.* 72, 73., is right-handed.

Threads usually of an inferior quality twisted up moderately taut, and seldom exceeding 9, are called *Spun yarn.* Spun yarn plaited into a soft flat rope is called *Sennit.*

Threads, usually two, unlaid, rubbed down, twisted up the reverse way, and then spun up together right-handed, are called *Nettle stuff.*

Threads twisted together by hand in short lengths, are called *Foxes.*

Foxes plaited together after forming an eye, make *Reef Points* or *Gaskets.*

"In hawser-laid rope the strength of each yarn is greatest in the smaller sizes: thus, in a 12-inch rope the average strength is 76 pounds; in 6-inch, 78 pounds; in 1½-inch, 93 pounds; in 1-inch, 95 pounds; and in ½-inch, 104 pounds per thread.

"All rope made with 4 strands is weaker than that which is made with 3 in proportion of about ⅕.

"A strain of half the full strength of any rope or chain, constantly

or even frequently applied, will eventually (before its evident decay from wear) break it: this maxim applying with greater force to crane chain than to chain cable, and with still greater force to rope, particularly cable laid."* Italian hemp is considered superior to all others. Three-and-a-half-inch ropes were tested in 1856; and whilst the one made of Riga hemp broke at 3 tons 15 cwt., that of Neapolitan did not carry away until a strain of 5 tons was applied.

Cat-falls, gunners' gear, bolt rope, lanyards of lower rigging, topsail ties, halyards, lifts and braces are all made of Italian hemp.

Coir Rope is made from the fibres of the cocoa-nut tree. It is equal in strength to hempen rope of the same size, and is but two thirds of the weight. As it floats it is most useful for warps, but decays rapidly when stowed away wet.

The rough rule for measuring the strength of ropes, is to multiply it by its circumference and divide by five; but this applies only to the very best cordage.

To ascertain its weight, the square of the circumference divided by 4 equals the weight of a fathom in pounds; or multiply the square of the circumference by the length in fathoms, and divide by 480 for weight in cwts.

When ropes are broken, they are joined by *Splices*. If they reeve through blocks, a *Long splice* is used; otherwise a *Short splice*. In short splices when there is no service the ends should be put through twice each way; when the ends are served down, once and a half is sufficient.

All *splices* are weaker than the rope itself by one eighth.

When a strand of a rope is *chafed*, it is cut out and another interwoven in lieu.

When rope is exposed to much chafe, it is preserved by filling up the openings with spun yarn or strands, a process which is called *Worming*. This is covered with strips of tarred canvass; which is called *Parcelling*; and this is again with turns of spun yarn, called *Serving*. Tar before worming; worm and parcel with the lay, and serve against the lay, as a general rule; but as it is an object to exclude wet, the eyes of standing rigging are parcelled towards the centre: thus the upper edges are covered after the manner of slate roofing.

* Tinmouth.

Backing is smaller stuff laid in after worming, so as to make the rope more round.

Throat Seizings are put on when ropes cross; the turns are passed round and round six over seven, without any crossing turns.

Round Seizings have two cross turns.

Flat Seizings have no riding or upper turns.

All Seizing Stuff should be well stretched before use.

Of the three different modes of turning in dead eyes, the splice is the weakest; the cutter stay fashion next; and the old way of securing with throat and end seizings, is so strong as to break the rope.*

In forming cables, the splicing tails are stronger than the artificial eye, but the tails must be well covered.

Straps made of small rope are said to be *Warped*; when of yarns, *salvagee*. The warped are stronger than rope of the same size.

Two men can worm and serve seven fathoms of 3½-inch rope in an hour; or worm, parcel, and serve 3 fathoms of 7-inch in an hour.

Three men can worm, parcel, and serve 2 fathoms of 12-inch in an hour.

One man can make 9 feet of 9 yarn sennit in an hour.

Six men can make an Elliott's eye in 1 day in a 24-inch cable.

Four men can do the same with a 15-inch cable: but will require an occasional help for a pull.

TABLE, *showing the sized chain or wire rope which is used as a substitute for hempen rope.*

Hemp.	Chain.	Wire.
3	$\frac{5}{16}$	$1\frac{1}{2}$
4	$\frac{3}{8}$	$1\frac{3}{4}$
5	$\frac{1}{2}$	2
6	$\frac{5}{8}$	$2\frac{1}{2}$
7	$\frac{3}{4}$	3
8	$\frac{7}{8}$	$3\frac{1}{2}$
9	1	4
10	$1\frac{1}{8}$	$4\frac{1}{2}$
11	$1\frac{1}{4}$	5

* Tinmouth.

TABLE, *showing the strength of chain, hemp, and wire rope.*

Hawser Laid Rope.			Round Linked Crane Chain.				Wire Rope.			
Size, circumference.	Weight, 100 Fathoms.	Mean Strain.	Size.	Mean.	Testing Strength.	Weight, 100 Fathoms.	Size.	Breaking Strain.	Working Load.	Weight per Fathom.
	lbs.				tons.	lbs.		tons.	cwts.	lbs.
12	2940	40·0	1⅝	73·0	30·6	15,569	4⅝	40	120	20
11½		36·7	1½	62·3	27·0		4½	36	108	18
11		33·6	1 7/16	57·4	24·7		4⅜	32	96	16
10½		30·7	1⅜	52·8	22·6		4¼	30	90	15
10	2136	27·9	1 5/16	48·4	20·6		4	28	84	14
9½		25·2	1¼	44·1	18·8		3¾	24	72	12
9	1712	22·6	1 3/16	40·1	17·0		3½	20	60	10
8½		20·2	1⅛	36·3	15·3	7,481	3¼	17	51	8½
8	1379	18·0	1 1/16	32·7	13·6		3	15	45	7½
7½		15·8	1	29·3	12·0	6,490	2¾	13	39	6½
7		13·8	15/16	26·1	10·5	5,600	2½	11	33	5½
6½		12·0	⅞	23·1	9·1	4,500	2¼	9	27	4½
6	834	10·3	13/16	20·4	7·9	4,000	2	7	21	3½
5½	712	8·7	¾	17·3	6·8	3,449	1¾	5	15	2½
5		7·2	11/16	14·6	5·6	2,900	1½	3	9	1½
4½	413	5·9	⅝	12·0	4·6	2,538	1	2	6	1
4		4·7	9/16	9·7	3·8	2,001				
3½		3·7	½	7·7	3·0	1,583				
3	203	2·8	7/16	5·9	2·3	1,060				
2½		2·1	⅜	4·3	1·6	827				
2		1·4	5/16	3·0	1·1	581				
1¾		1·23	¼	1·9	·75	392				
1½		·88	3/16	1·0	·42					
1¼		·66								
1		·51								
¾		·46								
½		·28								

TABLE, *showing the number of Threads and Weights of different sized Bolt Rope.*

White.										Tarred.									
30-thread Yarn.					40-thread Yarn.					30-thread Yarn.					40-thread Yarn.				
Size.	Thread.	Weight.			Size.	Thread.	Weight.			Size.	Thread.	Weight.			Size.	Thread.	Weight.		
		cwts.	qrs.	lbs.			cwts.	qrs.	lbs.			cwts.	qrs.	lbs.			cwts.	qrs.	lbs.
1	12	0	1	0	1	15	0	0	26	1	12	0	1	5½	1	15	0	1	3¼
2	39	0	3	2	2	54	0	3	6	2	89	0	3	20	2	54	0	3	24
3	90	1	3	4	3	120	1	3	4	3	90	2	0	16	3	120	2	0	16
4	159	3	0	18	4	213	3	0	19	4	159	3	3	4	4	213	3	3	6
5	249	4	3	21	5	333	4	3	23	5	249	5	3	20	5	333	5	3	22
6	360	7	0	15	6	480	7	0	16	6	360	8	2	8	6	480	8	2	8
7	489	9	2	21	7	654	9	2	26	7	489	11	2	16	7	654	11	2	20
8	639	12	2	18	8	852	12	2	20	8	639	15	0	24	8	852	15	0	24
8½	723	14	1	9	8½	963	14	1	9	8½	723	17	0	24	8½	963	17	0	22

TABLE, *showing the number of Threads, Weights, and Strength of different sized Hemp Cables.*

Cables, 101 Fathom, 20-thread Yarn.						Cables, 101 Fathom, 20-thread Yarn.						Cables, 101 Fathom, 20-thread Yarn.						Transporting Cables, 128 Fathom, 20-thread Yarn.		
Size. Inch.	Threads No. of.	Weights.			Strength.	Size. Inch.	Threads. No. of.	Weights.			Strength.	Size Inch.	Threads. No. of.	Weight.			Strength.	Weight.		
		cwts.	qrs.	lbs.	tons.			cwts.	qrs.	lbs.	tons.			cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
2	27	1	0	1		10½	576	20	2	8	21·4	19	1881	67	0	20	66·6			
2½	36	1	1	11		11	630	22	2	0	23·7	19½	1980	70	2	24	71·3			
3	54	1	3	20	1·5	11½	693	24	3	0	26·1	20	2088	74	2	8	76·1	2	1	19
3½	72	2	2	8	2·1	12	756	27	0	0	28·6	20½	2196	78	1	20	80·6	3	0	25
4	90	3	0	24	2·7	12½	810	28	3	20	31·3	21	2304	82	1	4	85·3	4	0	4
4½	108	3	3	12	3·4	13	882	31	2	0	33·3	21½	2412	86	0	16	90·1	4	3	10
5	135	4	3	8	4·3	13½	954	34	0	8	35·4	22	2529	90	1	8	95·	6	0	6
5½	162	5	3	4	5·3	14	1026	36	2	16	37·6	22½	2646	94	2	0	100·1	7	1	1
6	189	6	3	0	6·3	14½	1098	39	0	24	39·9	23	2763	98	2	20	100·7	8	1	25
6½	216	7	2	24	7·5	15	1179	42	0	12	42·3	23½	2880	102	3	12	101·3	9	2	20
7	252	9	0	0	8·8	15½	1251	44	2	20	44·3	24	3006	107	1	12	101·9	11	1	5
7½	288	10	1	4	10·2	16	1332	47	2	8	46·5	24½	3132	111	3	12	102·5	12	3	18
8	333	11	3	16	11·7	16½	1422	50	3	4	48·7	25	3267	116	2	20	103·2	14	3	19
8½	378	13	2	0	13·4	17	1512	54	0	0	51·	25½	3393	121	0	20	107·3	16	3	21
9	423	15	0	12	15·2	17½	1593	56	3	16	53·4	26	3528	126	0	0	111·6	18	3	23
9½	468	16	2	24	17·1	18	1692	60	1	20	57·7									
10	522	18	2	16	19·2	18½	1782	63	2	16	62·1									

Table, showing the number of Threads and Weight of Hawser-laid Rope, three strands, tarred, 113 fathoms.

	20-thread Yarn.								25-thread Yarn.							30-thread Yarn.			
Size.	Thread.	Weight, Tarred.			Weight, White.			Weight, White.			Weight, Tarred.			Thread.	Weight, Tarred.			Thread.
		cwts.	qrs.	lbs.	cwts.	qrs.	lbs.	cwts.	qrs.	lbs.	cwts.	qrs.	lbs.		cwts.	qrs.	lbs.	
½	...		...			..		0	0	17	0	0	20	6	0	0	17	6
¾	6	0	0	23½	0	0	21	0	0	25	0	1	2	9	0	0	25	9
1	9	0	1	10	0	1	3¼	0	1	8¼	0	1	12	12	0	1	6	12
1¼	12	0	1	20	0	1	14	0	1	12	0	1	20	15	0	1	20	18
1½	18	0	2	16	0	2	4	0	2	0	0	2	11	21	0	2	8	24
1¾	21	0	3	0	0	2	14	0	2	16	0	3	9	27	0	3	24	30
2	27	0	3	24	0	3	6	0	3	4	0	3	21	33	0	3	20	39
2¼	33	1	0	20	0	3	26	1	0	0	1	0	22	42	1	0	24	51
2½	42	1	2	0	1	1	0	1	0	24	1	1	23	51	1	2	0	63
2¾	51	1	3	8	1	2	2	1	2	0	1	3	5	63	1	3	4	75
3	60	2	0	16	1	3	4	1	3	4	2	0	16	75	2	0	16	90
3¼	69	2	1	24	2	0	6	2	0	8	2	1	26	87	2	2	0	105
3½	81	2	2	16	2	1	18	2	1	20	2	3	18	102	2	3	20	123
3¾	93	3	1	8	2	3	9	2	3	4	3	1	10	117	3	1	12	141
4	105	3	3	12	3	0	21	3	0	16	3	3	2	132	3	3	4	159
4¼	120	4	1	4		...			..		4	1	4	150	4	1	4	180
4½	135	4	3	8	4	0	2	4	0	0	4	3	6	168	4	3	4	201
4¾	...		...			...			...			...		...	5	1	12	225
5	168	6	0	0	5	0	0	4	3	20	6	2	18	207	5	3	20	249
5½	201	7	0	20	5	3	26	6	0	0	7	3	22	252				
6	240	8	2	8	7	0	16	7	0	16	8	0	8	300				
6½	282	10	0	8	8	1	16	8	1	12	10	0	3	351				
7	327	11	2	20	9	2	26	9	2	24	11	2	17	408				
7½	375	13	1	16	11	0	18	11	0	16	13	1	13	468				
8	426	15	0	24	12	2	20	12	2	24	15	1	0	534				
8½	483	17	1	0	14	1	14	14	1	12	7	0	25	603				
9	540	19	1	4	16	0	8	6	0	8	19	1	4	675				
9½	603	21	2	4	17	3	22	17	2	20	21	2	1	753				
10	666	23	3	4	19	3	8	19	3	12	23	3	8	834				
10½	735	26	1	0	21	3	14	21	3	12	26	0	25	918				
11	807	28	3	8	24	0	2	24	0	0	28	3	5	1008				
11½	882	31	2	0	26	1	0	26	0	24	31	1	23	1101				
12	960	34	1	4	28	2	0	28	2	8	34	1	4	1200				

Hawser-laid, four strands, tarred, 106 fathoms.

20-thread Yarn.

Size.	Thread.	Weight. cwts.	qrs.	lbs.
3	61	2	0	17
3¼	69	2	1	2
3½	82	2	3	17
3¾	95	3	1	12
4	108	3	3	8
4¼	121	4	1	3
4½	134	4	2	27
4¾				
5	169	5	3	25
5½	204	7	0	24
6	243	8	2	10
6½	286	10	0	13
7	329	11	2	16
7½	377	13	1	10
8	429	15	0	19
8½	490	17	1	9
9	546	19	1	7
9½	611	21	2	13
10	672	23	3	2
10½	741	26	0	24
11	815	28	3	9
11½	893	31	2	10
12	971	34	1	11

25-thread Yarn.

Size.	Thread.	Weight. cwts.	qrs.	lbs.
1¼	21	0	2	11
1½	28	0	3	0
2	34	0	3	25
2¼	43	1	0	26
2½	51	1	1	24
2¾	64	1	3	10
3	73	2	0	11
3¼	85	2	0	21
3½	102	2	3	20
3¾	115	3	1	6
4	132	3	3	5
4¼	149	4	1	3
4½	166	4	3	2
4¾				
5	209	6	0	0
5½	252	7	0	27
6	299	8	2	10
6½	350	10	0	7
7	405	11	2	16
7½	465	13	1	12
8	533	15	1	7
8½	602	17	1	6
9	670	19	1	1
9½	751	21	2	10
10	828	23	3	5
10½	913	26	0	27
11	1003	28	3	9
11½	1097	31	2	4
12	1195	34	1	31
12½	1297	37	1	3
13	1404	40	1	11
13½	1510	43	1	17

30-thread Yarn.

Size.	Thread.	Weight. cwts.	qrs.	lbs.
1¼	25	0	2	11
1½	30	0	2	26
2	38	0	3	19
2¼	51	1	0	26
2½	63	1	2	2
2¾	72	1	2	27
3	89	2	0	17
3¼	101	2	1	21
3½	122	2	3	22
3¾	139	3	1	12
4	156	3	3	3
4¼	177	4	1	5
4½	198	4	3	4
4¾	220	5	1	9
5	245	5	3	20

Hawser laid, 106 fathoms, four strands, tarred, 30-thread. Shrouds and stays.

Size.	Thread.	Weight. cwts.	qrs.	lbs.
1¼	25	0	2	11
1½	30	0	2	16
2	38	0	3	19
2¼	51	1	0	26
2½	63	1	2	2
2¾	72	1	2	27
3	89	2	0	17
3¼	101	2	1	21
3½	122	2	3	22
3¾	139	3	1	12
4	156	3	3	3
4¼	177	3	1	3
4½	198	4	3	4
4¾	220	5	1	9
5	245	5	3	20

Tacks, 25-thread yarn, tapered.

Fathoms per pair.	Weight. 3 in.			3½ in.			4 in.			4½ in.			5 in.			5½ in.			6 in.			6½ in.		
10	0	0	17	0	0	24	0	1	2	0	1	12	0	1	21	0	2	3	0	2	16	0	3	0
20	0	1	7	0	1	20	0	2	7	0	2	24	0	3	16	1	0	6	1	1	4	1	2	0
30	0	1	25	0	2	17	0	3	10	1	0	8	1	1	8	1	2	10	1	3	20	2	1	0
40	0	2	15	0	3	13	1	0	14	1	1	21	1	3	2	2	0	13	2	2	8	3	0	0
50	0	3	5	1	0	9	1	1	18	1	3	5	2	0	24	2	2	17	3	0	24	3	3	0
60	0	3	22	1	1	6	1	2	21	2	0	17	2	2	17	3	0	20	3	3	12	4	2	0
70	1	0	12	1	2	2	1	3	25	2	2	1	3	0	11	3	2	23	4	2	0	5	1	0
80	1	1	2	1	2	27	2	1	0	2	3	13	3	2	5	4	0	27	5	0	16	6	0	0
90	1	1	20	1	3	23	2	2	4	3	0	26	3	3	26	4	3	2	5	3	4	6	3	0

Signal-halyards stuff is made of strands that have been laid up in opposite ways, so as to lessen that tendency to taking in turns which is so inconvenient in hoisting flags.* It is laid up in lengths of 113 fathoms, and from ¾ to 1¼ inch in circumference.

BLOCKS.

Ship's Blocks are made of elm, having either metal or lignum vitæ sheaves, with a metal bouching and iron pin.

Their size is denoted by the length of the shell, and their quality by their degree of flatness or thickness, number of sheaves, scores for stropping, and nature of stropping. For instance, a brace block is (say) 20-inch, single, thin, and double scored. A tye block is, single, thick, and iron bound.

Clump Blocks are made shorter and thicker, and have metal sheaves, which are smaller in diameter than those of other blocks which reeve the same sized rope.

Shoulder Blocks, such as purchase ones, are made with a projection left on the shell, which prevents the falls from being jammed against the sheers, &c.

The *Fiddle Block* is a large and small single block made on end in one piece, each being equally large in the *swallow*. The parts of rope are kept more clear of each other in this kind of block, and as they do not cross, there is less friction; but as the upper sheave is smallest in diameter, there is a loss of power.

Sister Blocks are also two in one on end, but are of the same size. They are only used where two different ropes lead from similar directions, but well apart, as in the case of topsail lifts and reef-tackles.

Iron stropped blocks have either a swivel or standing hook. In the case of snatch blocks, the binding is cut through to receive the rope, and is connected by a clamp, which should be locked whenever the rope is rove.

Blocks should frequently be examined, not only as to strapping, but also by knocking the pin out, and inspecting the bouching. The loss of power, and strain on rope occasioned by a worn bouche is considerable. The working blocks of tackles,

* In fitting flags, *Sennit* distance lines are less liable to take turns than is rope of *any kind*.

(for instance, the fly block of top-sail halyards) are always more worn than the lower ones, and therefore without waiting until the sheaves shriek and become dumb, the blocks should be shifted and the sheaves transposed. This remark applies also to quarter-davits. That sheave on which the hauling part of the rope works does most duty: for although it is assumed in mechanics that strain is equally borne by all parts of a rope in a tackle, practice proves that the hauling part is most worn and strained. If, for example, we have a weight of 3 cwt. suspended by a luff-tackle, the upper block being fixed, and we hang a weight of 1 cwt. to the fall, the 3 cwt. would be balanced, but the fixed block would bear a weight of *four cwt.* And there is something of this kind which calls for greater strength, and frequent alteration in upper blocks.

All blocks which stand horizontally—as lower brace blocks—must be placed with the square end of the pin upwards; as, when the shell shrinks, it is liable to fall out if placed otherwise.

Hanging, *Tye*, and *Quarter Blocks* undergo great strains when bracing sharp up; if the former are two blocks, the weather halyards should be eased up sufficiently.

Cat Blocks are liable to split, if not unhooked before catting the anchor. So are *Jeer Blocks*, if hove together, as sometimes happens in the excitement of heaving up lower yards.

The *Language of Blocks* is a most useful study. When their natural desire to "*look* to their work" is not gratified, they complain loudly. "If that block could speak, what would it say?" was a favourite question of a celebrated old officer who was not friendly to the over neat rigging mania that obtained in those times, when foot-ropes were stopt up, and gear was unrove to make a ship look "nice."

There is a regular proportion for the size of rope *stropping*; and the blocks are fitted either with a hook and thimble, a lashing eye, or with a tail. The splice of the strop is always placed at the lower part of the block.

A block is *double stropped* when it is desirable to give it a different stand to what it would have with a single one, as in the case of brace blocks.

Gun Tackle Blocks are usually stropped with a grummet. One

man can fit about 11 of these in a day of 9½ hours' work; or 12 common, serving his own strop.

Blocks should be three times the size of the rope rove in them.

TABLE *of size of rope stropping.*

Blocks.	Rope.	Blocks.	Rope.	Blocks.	Rope.	Blocks.	Rope.
5	1	10	3	15	5	20	7
6	1½	11	3½	16	5	21	8
7	2	12	4	17	6		
8	2½	13	4½	18	6		
9	3	14	5	19	7		

Weight of wooden blocks.

Description.	Size.	Weight.			Description.	Size.	Weight.			Description.	Size.	Weight.		
	in.	cwt.	qrs.	lbs.		in.	cwt.	qrs.	lbs.		in.	cwt.	qrs.	lbs.
Single.	4	0	0	0¾	Double.	4	0	0	1					
"	5	0	0	1	"	5	0	0	1½					
"	6	0	0	1½	"	6	0	0	3	Treble.	6	0	0	4
"	7	0	0	2½	"	7	0	0	4½	"	7	0	0	6
"	8	0	0	3½	"	8	0	0	6	"	8	0	0	8
"	9	0	0	5	"	9	0	0	8	"	9	0	0	10
"	10	0	0	6½	"	10	0	0	10	"	10	0	0	14
"	11	0	0	8	"	11	0	0	14	"	11	0	0	18
"	12	0	0	12	"	12	0	0	20	"	12	0	0	23
"	13	0	0	16	"	13	0	0	27	"	13	0	1	3
"	14	0	0	18	"	14	0	1	3	"	14	0	1	14
"	15	0	0	20	"	15	0	1	7	"	15	0	1	24
"	16	0	0	24	"	16	0	1	11	"	16	0	2	7
"	17	0	0	27	"	17	0	1	24	"	17	0	2	20
"	18	0	1	4	"	18	0	2	3	"	18	0	3	0
"	19	0	1	13	"	19	0	2	15	"	19	0	3	18
"	20	0	1	21	"	20	0	3	0	"	20	1	1	10
"	21	0	1	24	"	21	0	3	8	"	21	1	1	19
"	22	0	2	6	"	22	1	0	4	"	22	1	2	0
"	23	0	2	25	"	23	1	0	24	"	23	1	2	10
"	24	0	3	2	"	24	1	1	17	"	24	1	2	20
"	25	0	3	18	"	25	1	2	4	"	25	1	3	17
"	26	1	0	8	"	26	1	3	9	"	26	2	0	14

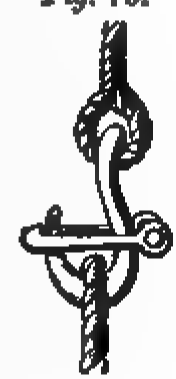
The largest sized blocks made in one piece are 28 inches. Careening blocks, which are built, are as large as 42 inches, and are usually made with metal sheaves.

TABLE *of the size and weight of purchase blocks, and the number allowed to each rate.*

	Size.	No. Four-fold.	Weight.	No. Three-fold.	Weight.	No. Two-fold.	Weight.
	in.		cwt. qrs. lbs.		cwt. qrs. lbs.		cwt. qrs. lbs.
	42	...	8 3 0	...	8 0 0	...	7 1 0
	36	...	6 0 0	...	5 2 0	...	5 0 0
Ships of Line -	30	1	4 3 8	1	3 3 0	...	3 2 0
1st Class Frigates	28	1	3 4 0	1	2 2 0	...	...
2nd " -	26	1	3 0 0	1	2 0 0	...	...
3rd " -	24	1	2 2 20	1	1 3 0	...	...
6th " -	20	...	..	2	0 3 20	...	...
7th " -	17	...	...	2	0 2 9	...	...
Remaining Ships	16	...	...	2	0 2 0	...	...
and Brigs -	15	...	...	2	0 1 23	...	...

There is no proportion for *hooks*, so that whilst handling heavy weights, unless the hooks be evidently very strong, it is safer to use a shackle or a lashing. More accidents happen from open hooks than from chain or cordage. Great support may be given a hook by slipping a link or a shackle over the point, thus (*fig.* 75.)*

Fig. 75.



Thimbles are made both perfectly round, and also with the ends nearly joined. Two are sometimes united for the purpose of giving easy play to the adjoining strops or block, as well as a different stand.

Metal blocks are occasionally furnished. When preserved rom rust they present much less friction than wooden ones. They are usually denominated by their lifting strength. The sketches may serve as patterns for good proportions of the scantlings for hooks, being on a scale of half the actual size.

The thickest are the upper edges.

Fig. 76.

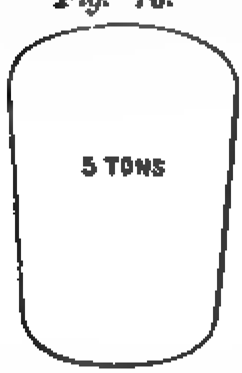


Fig. 77.

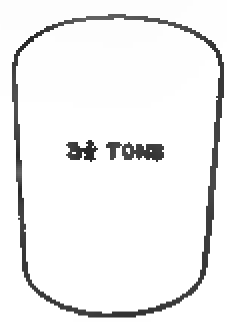


Fig. 78.

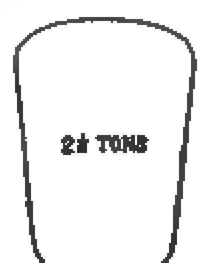
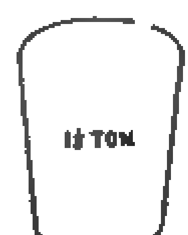


Fig. 79.



* *One great advantage in* Bothway's blocks, is that the hook may be unshipped *and a shackle substituted at pleasure*

Iron Blocks.

Weight to carry.	Diameter of Sheaves.	Thickness of Sheaves.	Size of Rope used.	Size of Chain.	Length of Shell of Block.	Weight of Blocks. (Double.)	Weight of Blocks. (Treble.)
tons.	in.	in.	in. circum.	in. diam.	in.	lbs.	lbs.
1½	2⅝	⅝	1½	$\frac{5}{32}$	6⅛	9	10½
2½	3¼	$\frac{13}{16}$	2	$\frac{3}{16}$	7½	15	18
3½	3⅞	$\frac{15}{16}$	2½	¼	9½	23	26
5	4⅝	1⅛	3	$\frac{5}{16}$	10	29 (Quadruple).	35
8	8½	1½	3½	$\frac{11}{32}$	16½	85	74
11	9⅝	1⅝	4	⅜	18½	125	110

In dealing with iron gear, it is well to bear in mind that the limit of elasticity of wrought iron bars of 1 inch square, is about 10 tons, within which it stretches about $\frac{1}{10000}$ part of an inch to each ton of strain, returning to its former dimensions on the removal of strain. Beyond this the fibres become permanently fixed, and the breaking strain is about 25 tons. The rule in practice is not to subject such iron to more than 5 tons on every square inch of section.

STANDING RIGGING.

Each mast is supported from forward by "stays," from aft by "back-stays," and sideways by "shrouds." In order to connect additional supports when necessary, each lower and top-mast has its "pendants." The fore-mast is supported from forward by the bowsprit, and therefore the bowsprit has an extra number of stays. These above-mentioned ropes constitute the "Standing Rigging."

RUNNING RIGGING.

Each upper-mast is provided with the means of lowering or raising it; in top-masts called "top tackle gear," in top-gallant-masts, "mast ropes." Each yard is supported in its middle (the lower by "chain slings," the upper by "ties") and at the arms by "lifts." Each yard is moved about by its own "braces," carries a sail, and is fitted with a "jack-stay," to which the head of the sail is bent. Each sail has its sheets for spreading and halyards for hoisting it: also its "clue garnets," or "clue lines," or "down hauls," or buntlines, or leechlines, &c. &c., for taking it in; and each yard is provided with a "foot rope" for the men to *stand on whilst furling* the sail.

These and such like ropes constitute the "running rigging."

CUTTING OUT.

To cut the lower shrouds out of the "warp." To the length of the mast from the "deck to the lower side of tressle-tree," add the height of the thickness of the tressle-tree and bolster (on one side), and the depth which the chains are below the deck; take this as a perpendicular, and the length from the mast hole to the outer edge of the channel as a base, and the hypothenuse will be the length of one leg of the first pair. Fix two pegs in the ground this length apart; make the bare end of the warp fast to one of them, and "fake" the warp round and round both pegs, each turn *outside* the other until you have got the number of pairs required. When there is an odd shroud on each side, carry their bight of the warp 1½ fathom beyond the others, cut through all at the "standing" end, and mark the bights in their middle, numbering from the first pair in the centre to the last outside.

After thus "cutting out" the rigging, each piece of rope is hove out taut by tackles on their "bare" ends, and then wormed, parcelled, and served according to the marks. One round and a quarter of the mast head gives the *length* of the eye for seizing marks, but no allowance is made in the length of the shrouds for the eyes themselves, as the rope will always "heave out" that much, or about 1 inch to a foot.

Mast-head pendants are cut with the long leg (the after one) one third the length of the shroud, and the short one about the length of a runner block shorter. A thimble is spliced into each, and like the eyes of the rigging they are wormed, parcelled *towards* the eye, served and seized with a round seizing passed over a strip of tarred canvass.

Single pendants are formed with a cut splice in the eye. The mizen-mast has only one pendant.

The *Foremost shroud* is always served the whole way down; and if the upper part be done with thick sennit or small rope, there will be no occasion (except in very heavy motion) for swab-line mats. The other shrouds are served one third the length of the [illegible] o lower side tressle-trees.

[illegible] d with lashing (Flemish) eyes, the half [illegible] the long part. The eye itself is about [illegible] oss-tree.

The *Bobstay and Bowsprit shroud collars* are made with lashing eyes: the latter with long and short legs; and if the shroud be chain, with a thimble instead of the heart.

The *Fore stay collars* are frequently made of warped straps.

The *Bobstays* are leathered or served with sennit in the wake of the stem hole, and the collar seizings protected by a bolster.

RIGGING SHIP.

The masts having gantlines on their heads are placed according to design in their proper attitude by means of wedges driven in at the "partners." Battens are supplied for the purpose of measuring their "stand," preserving their straightness, and guarding against "belly," whilst setting up the shrouds and stays.

LOWER CROSS-TREES.

The starboard gantline is bent to the middle of the foremost cross-tree on its upper side, and stopped to the port arm three parts out; this supposes the cross-tree to be on the starboard side of the deck. When the arm is well over the tressle, cut the stop, sway across, and so on with the others. Bolt them well down *immediately*.

TOPS.

There is no rule as to whether the tops go on before or after the rigging. The mast is less disturbed in the partners, if the runners are first steadied up; but the men work better and more safely, fewer things fall from aloft, and the eyes of the rigging are better placed if the tops are put on at once.

A word about "taking turns." The cleats all stand aslant, and many a man, especially in fitting out, does not know how to take one properly. If it be taken the wrong way, on the order to lower it jambs; and most probably, when he is trying to clear it, the rope goes with a jerk out of his hands. The *wrong* way to deal with a weight is this: at the word "high enough," give the order "belay" or take a turn; "anybody" tries to do so; the men on the fall "stand easy;" many let go; the weight that took the whole party to raise, is suddenly borne by but a few of them and begins to fall; "anybody" misses his "catch;" down by the run goes the weight on top of somebody, and the fall, thus jerked away, "whips" everybody off their feet. Or else he does catch his turn; but it is thus (*fig.* 80.), and the rope must be pulled up again to clear it.

The right way is to name one or two men to attend the stopper, seeing that it is a dry one, and warning them not to quit until ordered; two more at least to belay and lower, and to see that there is a clear place to belay at. At the word, "high enough," give the order "stopper;" *when* that is done, "belay," and then, "off-stopper;"—the turn will be taken thus—(*fig.* 81.).

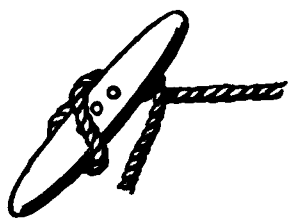


Fig. 80.

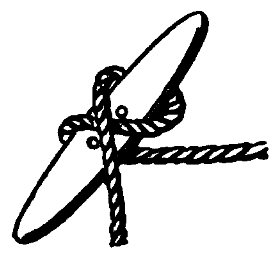


Fig. 81.

With very heavy weights, there ought to be a turn kept during the hoist, and the slack given in.

In lowering, one man should stand behind and pay the fall clear of kinks, into the other's hands; this especially should be done in lowering boats.

The least "surging" occurs in lowering, when you can have figure-of-eight turns over two "normans" or "pollards," or cleats.

Lowering on the capstan is very trying to rope; as, from the turns having a tendency to rise in a spiral direction up the whelps, it is necessary to "surge" occasionally, that is, suddenly to slack the rope, that it may return to its place.

The two capstans that may be observed revolving in opposite directions at the sheers, are arranged with the view of obviating this danger. They are connected by toothed wheels, and the rope is carried round each in the figure-of-eight fashion.

In working the capstan, keep the pauls down, stationing a blacksmith to attend them, and always *swift the bars.*

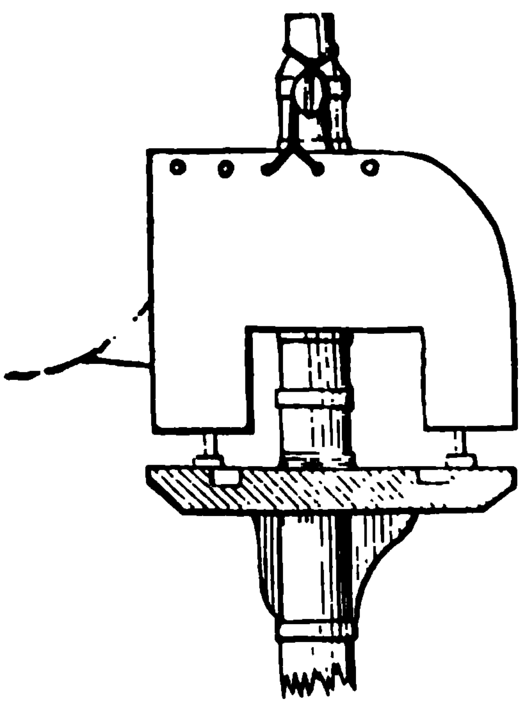
PLACING TOPS.

Say Main-half-top starboard. Bring both gantlines to the starboard side of the mast head; send the hauling parts down between the cross-trees, and the bending ones abaft the after *cross-tree. Lay* the half-tops on the deck on their own sides, *tops upwards, and* foremost ends forwards. Hitch the ends

of the gantlines round the middle of the lubber's hole trap, and stop them down to the top rim at the futtock plate hole, abreast this hitch. Lash boards — an ordinary deal will answer — athwart the tressle-trees, on their foremost and after parts; drive bolts into these boards, in a line with the centre of the mast head, leaving their upper ends projecting about six inches.

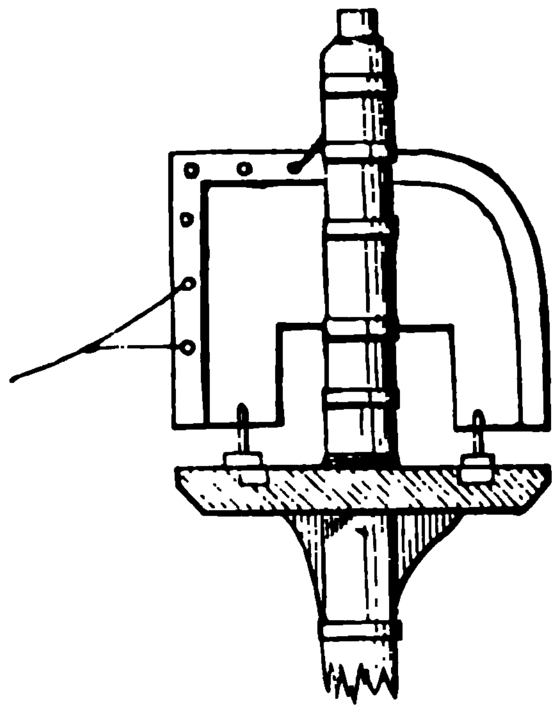
Bend the mizen gantline to the after part of the half-top through one of the stanchion holes. Trice up, and guy aft clear of the after cross-tree. When the top hangs on the side of the mast-head, it is easily placed with reference to its fore and aft

Fig. 82.



Starboard Half Top.

Fig. 83.



Port Half Top.

position, and on lowering and bearing off the rim, the middle parts will bear against the bolts, and the top will fall exactly in its place on the cross-trees.

In sending up whole tops, (say main,) place the gantlines on each side of the mast-head, having the hauling parts between the cross-trees and the bending ends abaft the after ones.

Stand the top athwart ships on the deck on its after end, having its lower side facing forward, and let it lean with its fore edge against the after part of the mainmast.

Bend the gantlines on their own sides, by passing them from before the top, and consequently along its under side, through lubber's *hole, through* an after futtock plate hole,

so as to keep the top heaviest on the fore part, and hitch the ends to their own parts. Stop the gantlines to the fore part

Fig. 84.

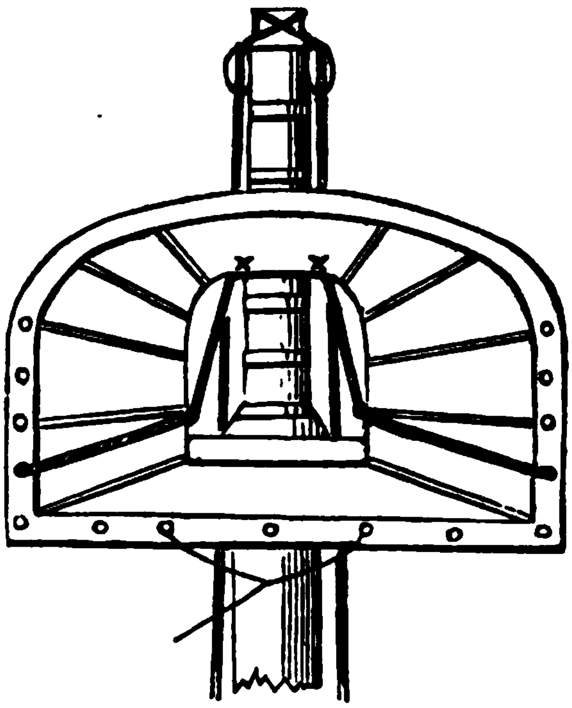
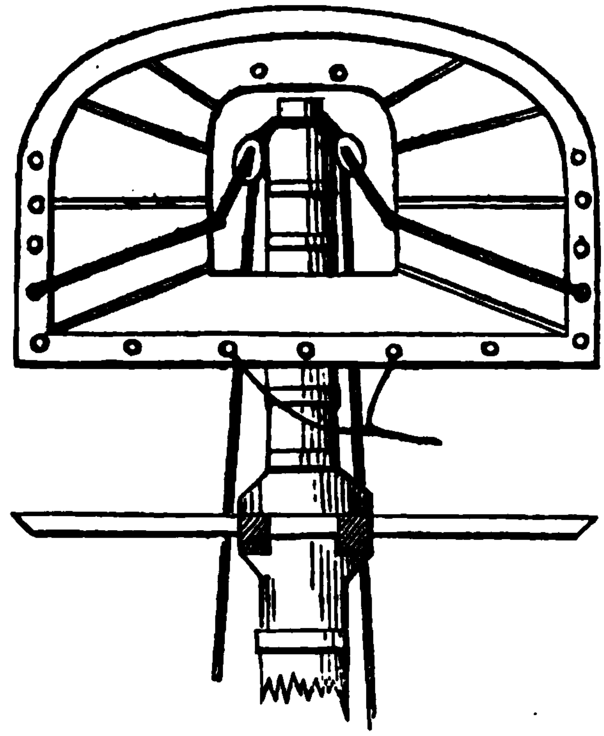


Fig. 85.



of the top through holes made for the purpose ; bend the mizen gantlines to the after part through the stanchion holes, guy aft and sway away. When the stops are up to the blocks, the foremost edge of the top will be pointing over the mast-head, and by hauling on the mizen gantlines it will be prevented from tilting aft when the stops are cut : this being done, the gantlines are pulled up, the top falls over the mast-head, and is placed on the cross-trees, and bolted down. (*Figs.* 84, 85.)

A mizen top is more easily sent up on the fore side, on account of the aid derived from the main gantline. Send it up after-part uppermost, bending the gantlines to the foremost futtock holes underneath the top, and stopping them at the after part of the top, guying off with the main gantline. In short, in sending up whole-tops from abaft, sling so as to be top-heavy on the fore part ; in sending down, sling so as to be top-heavy on the after part. As the mizen generally goes up and comes down before all, it must be top-heavy on the after part in the former, and on the fore part in the latter case.

BOWSPRIT.

The *Bowsprit* is filled up at the hole, and thus derives support there from the timbers, as the masts do at the partners; but it is also secured by two chain or rope-lashings called *Gammonings*, passed over the fore ends of these filling pieces on top of the bowsprit, and through holes in the stem. Chain is now invariably used, but the process of passing and setting up is similar.

The *Saddle* is tarred, the ends of the chain passed over the bowsprit (from the starboard side) through the holes in the stem, and shackled to their own parts; the turns are then passed with the other ends, so that the foremost ones on the bowsprit are the aftermost ones on the stem. Each turn is hove taut, as it is passed by reeving the gammoning through snatch-blocks made fast to the bobstay holes on the cutwater, bringing the bight through the hawse hole, and toggling on to tackles led from the capstan. Before shifting the tackle, each turn is secured by nails driven through the chain into the gammoning fish or saddle, and also by wedges driven into the stem hole. The last are frapping turns, passed over some well-greased hide, and set up by a tackle on a runner led through a block on the bumpkin.

In *rope-gammoning*, "Racking turns" with spun yarn would be used instead of nails, and the general rule is to set up the outer one first. Chain gammonings have been found to stretch considerably after much use, and should therefore be considered the first thing, when about to set up rigging.

The *man-ropes* are spliced into eyebolts on each side of the cap, and set up to the knightheads. When the forestays are "up," these are attached to them by "stirrups."

The *stage* is made of two spars, their heels secured on the head rails, and their heads crossed, lashed together, and suspended from the bowsprit; a platform of gratings enable the men to "clothe" the bowsprit.

The bowsprit is secured outside, downwards by the bobstays and sideways by the shrouds; the forestays pull upwards, and if they did so outside the bobstays, the spar would be strained; they are, therefore, generally secured between them.

The *Inner Bobstay Collar* is lashed on two thirds the length of the bowsprit *from the knighthead*. All the collars are fidded out

first, and then hove taut round the bowsprit by lashings set up with "a Spanish windlass." The bobstay collars are lashed on top, the forestay collars below, and the shroud collars on the quarters of the spar. All these collars are cleated in their place. When the forestay collars are warped straps, the lashing and heart is on the upper quarter. In some cases the strap is rove through its own part without any lashing. This warped strap plan is not "establishment," and therefore there is no pattern. The difficulty is to keep them from slewing round; their great utility is neatness, holding less wind, less liability of being shot away, and affording more room for handling the jibboom. The best kind, as they nip hardest, are made of small chain. The heart fashion has one merit which the warps have not; that is, in the case of the crupper breaking or slipping, the heel of the jibboom is prevented from flying up high enough to wring the cap.

Bobstays are rove, middled, and spliced, the hearts seized in, and the lanyards set up with a luff upon luff. These, as well as lanyards of stays, are more certain to bear equal strains on all parts, if they are set up by both ends at the same time. And all three bobstays should be pulled up together.

Bowsprit shrouds are now mostly of chain, with a rope lanyard at the collar, so that in case of carrying away the bowsprit, it may be readily cut away.

An extra bobstay,—the "*Cap bobstay*"—is sometimes fitted, reaching from the lower stem hole to the bowsprit just inside the cap.

When possible, the collars are lashed on the bowsprit before launching.

The *Bumpkin* is a fixture, and is secured by chain braces.

Whichever way the collars may be fitted, the clothing commences at two thirds the length of the bowsprit from the knighthead. This is the customary proportion; and if it admits of the foreyard being braced up as much as the mainyard, there can be no great object in carrying it further out. We must believe that this proportion was the result of long experience among mast makers: for it is often only when a spar has been returned to their hands that injuries are detected; and they are therefore *the best judges* as to the amount of strain which a spar can bear. *It is, however,* more desirable than ever to get a good angle for

the lower stays. Some steam ships contrive to carry courses effectively with the fore and aft sails when steaming near the wind, on occasions where the other square sails would not nearly draw.

The following is the order in which the bowsprit rigging occurs in each method, reckoning from inside:—

Heart plan.

1. Inner bobstay collar.
2. Bowsprit shroud, do.
1. Forestay, do.
1. Bobstay, do.
2. Bowsprit shrouds, do.
1. Forestay, do.
1. Bobstay, do.

Strap or bale sling plan.

1. Inner forestay collar.
1. Bobstay, do.
2. Bowsprit shrouds, do.
1. Forestay, do.
1. Bobstay, do.
2. Bowsprit shroud, do.
1. Bobstay, do.

In this way the forestay is placed inside for convenience in removing the collar when requisite.

SETTING UP BOBSTAYS.

There is a difficulty in setting the lanyards up on each end, owing to the confined space in which they stand. The next best method is this:—

Make the standing parts of the lanyards fast with a running eye round the bowsprit close to their respective collars, and reeve as many turns through the hearts as may be without riding: the object then is to set up in a line with the stand of the bobstays as much as possible. If there is any place on the stem where the lower blocks of the luffs can be hooked to, take them there: if not, they must either be hooked to straps on the lower parts of the bobstays or to the hawse holes. Hook the doubles below, the singles to the lanyards; lead the falls inboard through blocks on the bowsprit, and put long tackles again upon these. If the lanyards are rove with their standing parts on opposite sides alternately, the blocks may be kept clear of each other. When every thing has been drawn into its place, *shorten up for a final pull,* and walk all three down together;

rack the turns, and pass the riders, pulling them up short of cutting into the lower turns: rack these again, half hitch, seize down, and expend the end.

A shorter but less orthodox way is, to put the single blocks of the long tackles on the lanyards, hook the doubles at the hawse holes, lead the falls through blocks on the bowsprit, and put tackles on them.

Bowsprit caps are taken off and put on, after first fitment, with the jibboom, just as the lower caps are with topmasts.

Point the spar, lash it, heave out, bumping it beneath. The connecting bolt will be found on top of the bowsprit.

RIG A LOWER MAST.

Shift the gantlines to the after part of the tressle-trees for the rigging. Put a large toggle on the end of each gantline, and bend rounding lines to them. In sending up the rigging, put a stout temporary seizing on each pair of shrouds, about one third down, and instead of bending the gantline, insert the toggle under the seizing, and stop the upper part of the eye of the shroud to the gantline. When the bolster is tarred, and covered with canvass, the starboard pendants are first put on, then the port; their longest legs being aft. Trice the runners up, and lash them to the after legs of the pendants, clap the long tackles on the short ones, and take a good up and down pull on all four pendants, which will settle the foundation of the lower rigging very much. Pass a lashing across abaft the mast from one after pendant to the other, and carry the runners forward hand taut. The rule is then to place the foremost pair of starboard shrouds on first, then the foremost pair on the port side, and so on; but in the absence of very experienced riggers, there is more certainty of keeping the mast perfectly straight, if the after swifters are put on the first thing after the pendants, and the mast placed by them and the runners at once. On future occasions of setting up rigging, the convenience of being thus able to place the mast in the first instance will be found considerable.

In either case where the mast is large, it is very preservative *to lash* the runners to the mast on its fore part, one at the hounds *and the other near* the belly, and to keep the lower one on as

long as possible, even after the stays are up; so that the mast being thus a fixture at every point, the rigging is given time to draw in to exactly equal degrees of tension.

When there is time, it is well to pull and beat down each pair of shrouds as they are placed; and if the runners are fast to the mast, all four legs of the pendants are available for attaching tackles to.

The *Cap* is sent up through lubber's hole by the gantlines, both of which are brought to the same side for this purpose. It is placed in the top with its lower side downwards, and will be more easily got through the hole if it be sent up before setting up the rigging.

The lower lift blocks are double, and are generally stropped into the eyes of the iron band on the cap, before sending the cap aloft. Chain is now generally used for strapping.

The gantlines are shifted to the mast-head for the *Stays*, which are triced up with their legs on each side of lubber's hole, and the eyes are lashed one above the other abaft the mast-head.

In some cases the stays are carried over the foremost cross-trees, for the purpose of giving more room for the lower yard to brace up.

If the rigging is short, luffs are hooked to salvagee straps on the ends of the shrouds, and thus pulled down. Indeed, if there is a command of time, it is well to do this, whatever length the shrouds may be; for they can be much better marked for turning in when taut up and down, and the ends will be as small as the standing part.

TURNING IN LOWER RIGGING.

There is a confused and unmeaning way of speaking about "turning in dead eyes." One says, "with the lay;" another, "right-handed;" another, "with the sun;" another, "pass the end underneath the up and down part," and illustrates this lucid description with a hieroglyphic; another, "throw the end to your right." The puzzled candidate for the passing day, makes a tour of channels; for the question, "How do you turn in a dead eye?" is inevitable: he cannot escape it, often cannot find out how to answer it.

Let us speak about the right way first, and the present customary way afterwards; the former has reference *solely* to the good of the rope; the latter chiefly to appearance.

Take a piece of small right-handed rope, and hold about six inches of it taut out in both hands; twist it up tightly, and keep twisting as you bear your hands towards each other: the rope will make a natural curl, thus:

Fig. 86.

You have, in making the "*turn in*," kept the turn or twist in the rope: it is now as closely laid up at the bent part as any other, and consequently as little open to receive wet.

Again, with a similar piece of rope, untwist, and on bearing your hands together, it will form a natural curl, thus:

Fig. 87.

You have taken a turn *out*, and the strands lie open to wet.

It is true that, in making a turn with a large rope, you would neither twist nor untwist, but nearly the same effects would be produced.

Whether then in the loft or in the nettings ; whether with our own shroud rope, which is always right handed rope, or with foreign, which is sometimes left ; the only thing necessary to consider in the matter of turning in a dead eye, is to keep the turn in the rope, the reason being "so as to keep the wet *out*."

If the shrouds are to be "ends up," put a dead eye in the first curl, as in *fig*. 86. with its upper hole next the cross, (the scores being always well tarred first,) pass spun yarn seizings through the lower holes round the sides of the curl to keep the dead eye in its place. With a bolt through the upper hole (*fig*. 88.) and a strand, rig a Spanish windlass, and heave the end close to, and taut in ("breaking in" is the term), pass a throat seizing round the

Fig. 89.

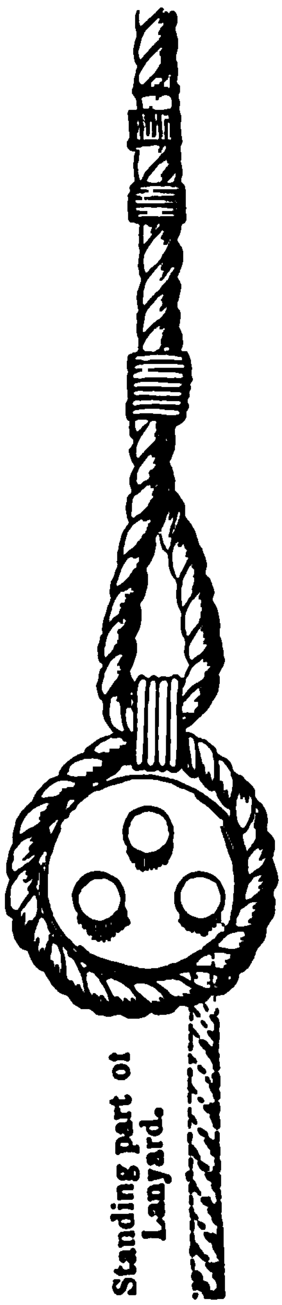
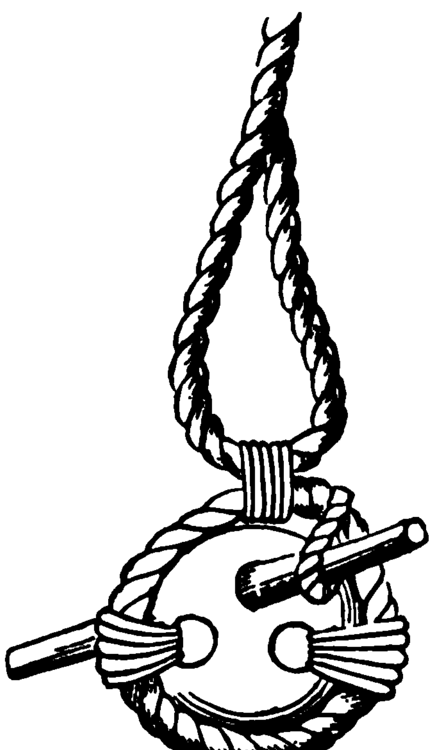


Fig. 88.

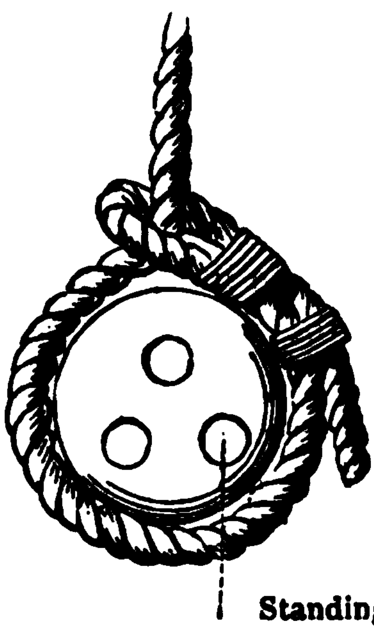


cross. Make the standing part of the shroud fast somewhere, haul the dead-eye hand taut from thence and make it fast. With a jigger on the *standing part*, pull the end taut up along it,

heaving the curved parts together at the same time; pass the quarter and end seizings (the quarter is a round one), and cap the end. (*Fig.* 89.)

To turn in *cutter stay fashion;* put a temporary seizing on the cross of the curl as in *fig.* 86.; carry the end round the standing part, and heave it taut alongside its own part; then seize those two end parts together with a throat seizing, making

Fig. 90.



Standing part of Lanyard.

the eye as small as possible, put a quarter seizing (a flat one) on as well, about six inches nearer the end; cut the temporary seizing on the cross, open out the clench, put in the dead eye, drive the clench down, keeping the dead eye with a little cant against the pull of the lanyard.

In all cases shrouds are placed with their ends inwards; otherwise the ends would be exposed to fray and wet. If put over the mast-head properly, these shrouds will naturally hang with their ends forward on the starboard side, and aft on the port side; but all ends will be inside, and the dead eyes will stand fore and aft without any sheer batten.

It is merely because this is not thought sightly that alterations are made, and the general practice now is to turn rigging in with the ends inside and aft: the strict rule, however, still obtains. "*With the lay*" is the rule: ends aft and inwards is merely the present custom.

The fig. 90 is a port dead eye, as seen from outside the ship.

Two seaman should turn in a dead eye with 11 inch rope in a workmanlike manner in 2 hours.

When channels are fitted with iron gear the shrouds are seized into thimbles. (*Fig.* 91.)

These Plates occupy the place of the lanyards, as *a*, *b* in A. The lower plate *b*, formed as a link (shown wholly in B), is attached to the chain plate; the upper plate, *a*, is double, receiving the shroud on a thimble through its bight: both are adapted for reefing, and are secured together by riding bolts, 1. and 2.

For setting up, a screw purchase is attached in connection with both plates, as shown in D.

Directions.—A and C represent a profile and front view of the plates as first fixed, and previous to any application of the screw, the shroud being turned in as taut as possible by tackle.

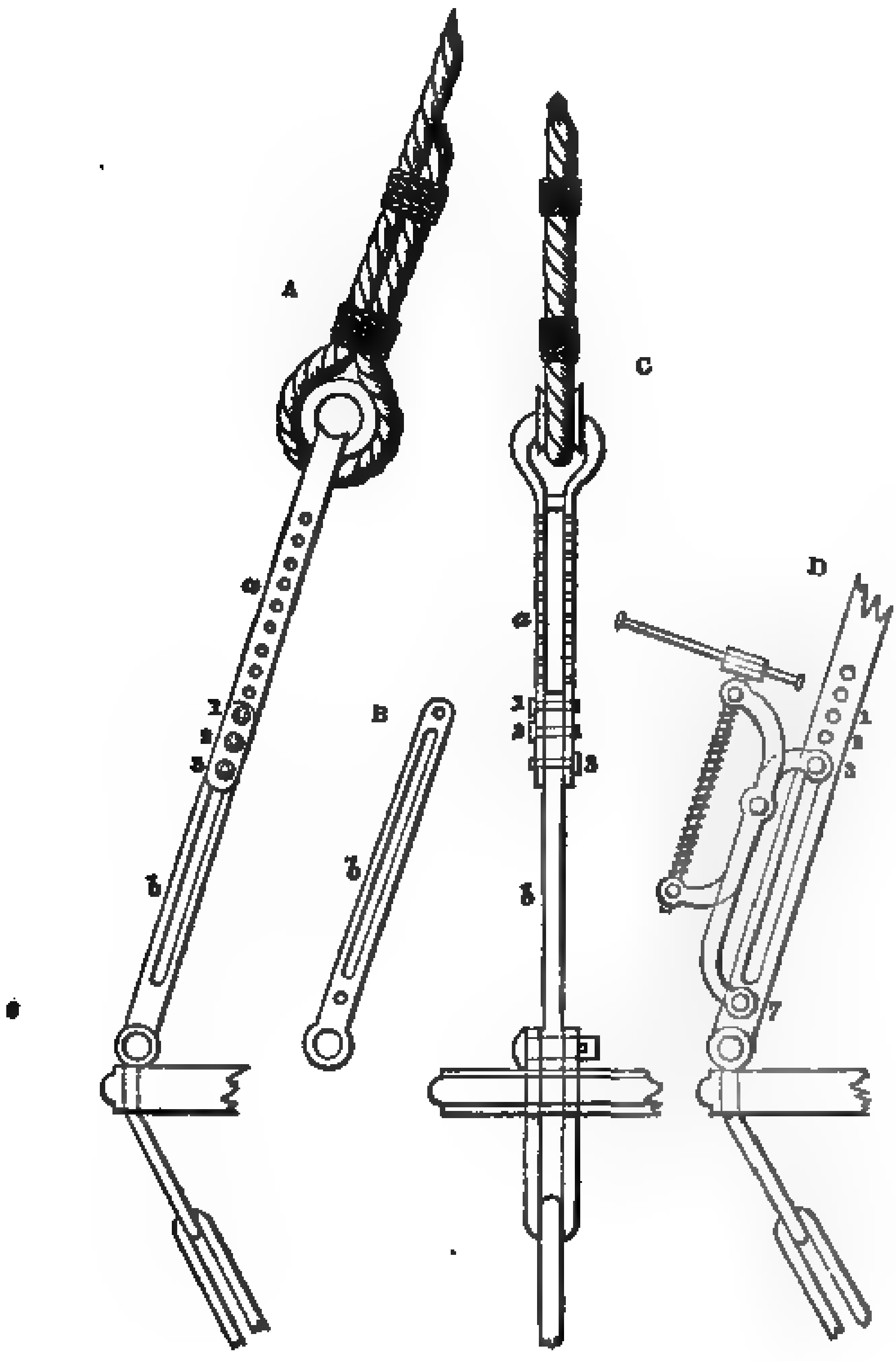
D shows the application of the screw purchase. For the process of setting up, take out bolt 3., which is always free, merely serving as a guide pin. Nos. 1. and 2. are the riding bolts, and consequently bear the strain of the shroud: fix the screw on the plates, as in D. Fix connecting bolt 6. into the hole previously occupied by the guide bolt 3., and work the screw upwards or downwards to adjust the proper distance for connecting 7. This done, commence heaving down as soon as the action of the screw relieves the riding 1. and 2.: withdraw No. 1. only. The upper hole in plate B being sufficiently longitudinal (say ½ inch) to give it freedom the moment the strain is off, No. 2. pin may be left in till the shroud is hove down as taut as desired, and No. 1. pin properly secured again to its advanced place. No. 2. is then shipped in advance and the point secured, on which the screw is "come up" and unshipped, and the guide pin replaced. The operation on this shroud being now complete, the same process is continued to the rest of the shrouds successively.

These fitments interfere less with ports than dead eyes, and set up more easily; but would occasion more damage if struck by shot.

REEVING THE LANYARDS.

Lanyards are always rove of well stretched rope. The rule is to reeve them *so as to have* the standing part under the end of

Fig. 91.



the shroud: thus the strain in pulling up is thrown chiefly on the upright part of the shroud, to the relief of the seizing.

The Chains are usually prepared with eye-bolts having thimbles, into which the standing ends of the lanyards are spliced. These eye-bolts are driven on the after side of each dead eye, so as to meet the arrangement of turning in we have alluded to. In the absence of eye-bolts the end is secured round the strop of the lower dead eye, or else it is knotted inside the upper one.

Lanyards are always half the size of the shroud.

SETTING UP RIGGING.

After the Runners are set up take the first pull with the long tackles alone, greasing the entering parts of the lanyards well. Pull up in pairs, with their opposites; beat the eyes and clenches down, putting a wad of junk on the part struck to preserve the rope. Commence with the foremost shrouds; and if the runners give out as the after ones are tautened, pull them up again. As the mast is secured in the partners by the wedges, it may be preserved in its natural straight line by due attention to the battens.

For the final pull, keep the after swifter fast, let go the rest. Set up the stays, and when fast, let go the upper runner, or both if abreast each other; hook luffs to strops on the shrouds, toggle their lower blocks to the lanyards, hook their falls on with Blackwall hitches to the long tackles, and pull up as before in pairs and opposites, beginning forward. If the stays give out, they must be pulled up again. Set the swifters up with the long tackles alone.

The Lanyards are secured by racking turns taken on all parts, passing the ends taut through between the upper ends of the upper dead eyes and the shrouds, and expending them round the shroud.

It is not unusual to half hitch the lanyards, but the Riggers do not adopt the custom.

The number of pulls which rigging should have depends so much on the state of the weather, as to forbid rules. If a fine dry night and warm morning succeeded a satisfactory pull on the preceding day, one pull about noon would take down as much as was good for it; but even then, that must be to an extent dependent on the destination of the ship. To plunge sud-

denly into a wet, cold climate with very taut rigging would be ruinous; but going into a hot one, the tauter the better.

Stays are usually turned in with hearts or round thimbles, either cutter stay fashion or end up. The main stays are sometimes passed round the cross piece of the fore bitts and secured to their own parts. Such fastenings, however, are neither so readily made as lanyards, nor admit of the stays being so easily slackened. These will be found important considerations whilst setting up the rigging on future occasions, as every thing stands fast until the stays are adjusted and secured.

Stay lanyards, when possible, should be rove on their bights, and set up on both ends at the same time. The top burtons on luffs will be sufficient setting up purchase, so that the long tackles need not be withdrawn from their employment on the shrouds. The eyes and lashings must be kept clear of each other at the mast head, and the fork of the stays exactly middled whilst pulling up.

Stay lanyards which set up on the end are rove on the same principle as that which applies to those of the shrouds; namely, the standing part under the end part of the stay. The eyes of the stays are usually triced up whilst setting up the shrouds at first, and are never set up until the rigging eyes are beaten down. The mast meanwhile hangs on the runners; which when lashed to the pendants, cause the mast to belly forward, affording an additional reason for lashing the runners to the mast, one being close up to the tressles.

RATTLING.*

Rattline stuff should be well stretched before use. In sparring and rattling the rigging, commence from below; both will thus be more surely placed horizontal. Let all the spare ends of spars be aft, otherwise they will interfere with lower yards and sails going up. In refitting rattlines, sling a spar with a span on a whip outside the rigging; two men can thus attend themselves, and avoid the delay of shifting seizings on a batten. Rattlines are clove hitched on the intervening shrouds, and seized to

* In stripping ship, it is usual to leave a line of rattlines on a pair of shrouds *to the last moment.* See that the shrouds are *pairs*, else the object will be defeated and the work be clumsily managed.

the foremost and aftermost but one. An occasional one, a catch rattline, is carried to the after swifter. Rattlines are placed fifteen inches apart, and secured at the ends with nettle stuff. If on splicing the eye the rattline be a little too long, and the rope has been well stretched, it may be twisted up. In rigging of nine shrouds a man will clap on four rattlines in an hour.

Marling spikes must be fitted with lanyards, which should be hitched to the shrouds, or worn round the neck. The two lower rattlines are made of rope sufficiently strong to bear the weight of the several men who crowd there whilst waiting for orders to go aloft.

Before *sparring*, the shrouds are slightly frapped together in a fore and aft line, and when the rattling is completed the frappings are cut away.

Network of rope is preferable as a covering for lanyards to matting. It is more easily made and removed; and as it admits air, and does not retain wet, is a better preservative.

TOP-MASTS.

If possible bring the top-masts alongside, so that the hawsers may be used in the live sheaves without shifting. Let us say maintop-mast in the water on the starboard side. Lash a top block on starboard side of main-mast head. Take as large a hawser from the capstan through the top block as it will reeve; reeve the end through the mast hole in the top between the stays, and then through the live sheave hole in the top-mast from aft forward (the after side will be known by the lightning conductor), and hitch it securely. Lash the hawser taut up from the hitch round the mast about two-thirds from the heel; hook the long tackle of that side to this lashing, and prevent the lashing from slipping up by backing it from the fid hole with a stout piece of rope. Heave the mast up with the capstan and long tackle, keeping the heel aft so as to clear the head of the top rim. Lower it down main hatchway until the head can be pointed through the stays and mast hole; then heave up, placing the round hole of the main cap over the mast hole, and land the heel of the mast on the deck close to the main-mast. Of course if the top-mast is shorter than the distance between the lower side of the tressle trees and the deck, it may be entered at once without being lowered down the hatchway. Cast the lashings and

end of the hawser off, trice its end up with the port gantline through the mast hole, and hitch it round the mast head on the port side. Heave up; and when the mast head is sufficiently through the cap, lash them together. Heave up again, and by means of slue ropes on the heel, the cap may be placed on the main-mast head. Place the cap shore, and as it is liable to work out, secure it with a lanyard. Land the mast on the deck again. If it be short, the head must be lashed round the main-mast before its top is clear of the tressle trees.

Light up the hawser; hook both top blocks to their respective bolts on the after sides of the cap. Hitch the end of the hawser now to the foremost cap bolt on the port side; reeve the port top tackle pendant through its top block, and heave the top-mast up for trial, entering the fid. Lower the mast, single the hawser, lash it as before, using the tackle, and place the mast on the deck, heel aft on the starboard side. Get the other top-mast up in like manner, putting gantlines on the head when through the cap, and fidding it for trial before rigging. Try the cross trees on the spare mast, and then place them on the main cap with the top-mast gantlines; lower the top-mast until the cross trees can be placed on the top-mast head, then heave the mast up to the striking mark. Reeve the port pendant through the dumb sheave; round the upper top tackle block up nearly as high as the necklace; haul the pendant taut through, and half hitch its end in the foremost cap bolt starboard side, seizing the end down. Haul this tackle taut, and belay; then unreeve the hawser and reeve the starboard top tackle gear, using the live sheave; haul it taut, belay, rack, and coil up the falls. The other masts are to be similarly handled, bearing in mind that the live sheave of fore top-mast is on the port side, and that the mizen top-mast is certainly short, may be entered at once, and must not be landed up and down the mizen-mast without a head lashing. Stow the spare fore and mizen top-masts on the port side, the former heel aft, the latter head aft.

FUTTOCK RIGGING.

Futtock rigging is sometimes of rope. The lower ends of the shrouds are lashed to the lower rigging, which is either supported there by a "spider" from the mast, or "cat harpen legs" from the shrouds themselves to their opposites. Although in a

large sized gang the rope fitments are lighter, there are so many reasons against them, that they have become obselete.

A comparison of chain and rope gear ran thus: —

	Chain.						Rope.					
	Weight.			Value.			Weight.			Value.		
	cwt.	qrs.	lbs.	£	s.	d.	cwt.	qrs.	lbs.	£	s.	d.
Futtocks - - - - -	12	3	0	14	13	0	8	0	16	12	17	9
Necklace or harpens - -	12	0	7	13	17	5	4	3	18	10	10	11
Coppering masts - - -	0	0	27	6	3	0						
Gammoning - - - -	29	2	18	35	19	1	11	2	11	16	19	3
Protecting woodwork - -	1	2	0	2	6	6						
	50	0	24	72	19	3	24	2	27	40	7	11

The dead eyes of the top-mast rigging are iron strapt, and those recently made swivel as the lower ones do. They are connected with the necklace of the lower masts by chain and iron bar shrouds: the foremost ones are usually chain. If the lower rigging has been well placed, there will be no difficulty in leading each futtock between the lower shrouds, and placing iron scotchmen to prevent chafe; but if the lower shrouds *ride*, there will not only be difficulty in reeving them, but constant fray afterwards. This is a fitment that demands great attention, for thick iron plates and a whole strand have been cut through in some ships during a gale.

CROSS TREES.

To place *cross trees* on the *lower cap* without the aid of the top-mast, pass one of the gantlines from underneath through the round cap hole, over the cap, down before all. Supposing it to be the main and on the portside — bend it underneath the cross tree to its port tressle tree; bend the port gantline also to the port tressle tree, and stop it out along the starboard cross tree; bend a guy from the fore top. Trice up and guy off. Throw a couple of ropes' ends over the lower cap, from the starboard side of the top; bend them to the starboard ends of the cross trees. Cut the stops, weigh down, and the gantline through the cap hole will carry the cross tree on top of the cap.

RIGGING TOP-MASTS.

The bolsters being scored out, the necklace is placed on the cross trees, and both are secured there before sending the cross

trees up. The necklace is a chain strop, having two open link legs on each side.

It will save trouble to shackle the tie blocks to the necklace before pulling up the rigging; and it will save the mast if the binding of these blocks be smoothed down at the edges and the pin ends be covered with leather.

Put the gantlines on the cross trees, and place the rigging; pendants first, then shrouds, commencing with first pair starboard side; then the back stays; then the stays. Top-mast pendants have but one leg. The sister blocks are seized in between the foremost shrouds below the seizing before sending the shrouds up; but these blocks have been tried in pendants separate from the shrouds, and found very efficient. Top-mast rigging is fitted in the eyes, and turned in with the dead eyes just as the lower rigging. The fore top-mast stays are rove through sheave holes in the bees of the bowsprit; one of them (the port one) having hanks rove on it first. The main top-mast stays are rove according to the nature of the *establishment*. If the ship has a large fore-trysail, these stays are rove through iron bound blocks on the fore-mast head near the cap. If not, one sets up in the fore-top; and the other, after reeving through a clump block on the after-part of the fore-mast below the top, sets up on deck. In this latter case, the lower stay of the two should be well protected with chafing battens, as the main braces usually cross over it. The mizen top-mast stay sets up in the main top. The masts being rigged, the sail tackles are hooked to the mast heads, the top burtons to the pendants, and the top tackle falls manned. As the dumb sheaves are only preventers, the bulk of the strength is thrown on the live falls, and the masts fidded. When the fid is in, equalise the strength and lift the masts; let go the live gear, and by lowering on the other, the masts will be slued square. When full rigged, this effect is produced generally by taking top-gallant braces from one mast to the cross trees of another.

TOP TACKLE GEAR.

When the tackle blocks are thus down, they can be squared and the pendants marked at the nips in the tops, taking care that there will be drift enough for unfidding—allowing for stretching—and also that the hooks of the upper blocks will not be above the futtock rigging after lowering the mast. In reeving the

falls, commence by reeving first through the leading block on the lower block, and have the swivel block uppermost. If there are no reeving lines kept in the top blocks, the top-sail bunt lines will carry the pendants up quite as well : bend them to the pendants about half way down, and stop the becket in the end to the bunt line. With the top blocks hooked, top tackle gear should be rove, with the jeers brought to, in less than ten minutes; therefore they should always be unrove after use.*

The foremost Main-top-mast Back Stay is mostly fitted as a shifting one, having a runner and tackle instead of a dead eye. French ships sometimes have stout long tackles, which are used for hoisting pinnaces out with ; the back stay, being hauled out to the lower yard arm, is secured there with a strop and toggle, and the lower block is overhauled to where it may be wanted.

All back stays should be served with sennit in the wake of braces, so as to avoid the use of matting.

The Sail Tackles are carried forward and steadied up, the rigging turned in, the lanyards rove either with a knot on the standing end, under the end of the shroud, or else it is passed with a running eye round the neck of the lower dead eye.

The rigging is set up with a Runner and the Top Burtons, the falls of which are led on deck.

The fore Top-mast Stays, after reeving through the sheave holes at the bees, pass through holes in the sprit sail gaffs, and set up in the head. They are well served some distance up, to protect them from the chafe of the jib sheets.

The Jib Stay is sent up before them, but the legs are passed down through their collars, and lashed abaft the mast head below them. Some jib stays are fitted with the end to a slip at the jib boom, and set up on deck abaft all after passing through a block at the mast head.

The Jib and Stay sail Halyard Blocks are shackled on to the necklace at fore top-mast head ; but a better lead is found by substituting eye-bolts for those which connect the foremost cross tree to the tressle tree. These being driven from beneath, and

* It has been recommended in cases where top tackle gear is suspiciously worn, to truss lower yards to whilst fidding top-masts ; for, in the event of the gear breaking, the heel of the mast would be brought up by the yard. As such precautions have been found to be successful in the arrest of danger, the suggestion *is very valuable.*

clenched above, afford means for hanging the head halyard blocks in a favourable position.

The top-masts are fitted, either with rail clasp hoops, or else the shrouds are crossed abreast the hanging blocks by futtock staves, which serve to confine the top gallant rigging below the cross trees.

The Top-mast Caps are sent up by the two mast-head gantlines sent down before all, the blocks of which should be placed as high as possible. Hitch the ends to the foremost eye-bolts, seize them to the after ones, and stop them at the fore part of the square hole. When the cap is up to the blocks, bend ropes' ends to its after end; pull down on these as the stops are cut and the gantlines are pulled up, and the cap will find its place.

The Span Blocks are single, hanging one on each side of the fore and main top-mast caps, for the top-mast studding sail halyards : the strops lie on top of the caps, and are seized to the cap bolts on each side.

The fore top-mast is also fitted with span fiddle blocks in long pendants on each side for the lower stud sail halyards, and top-mast stud boom topping lift.

TOP-GALLANT MASTS.

The Heels should be fitted with catch irons on the foremost side, to prevent them from being swayed through the tressle trees, an accident by no means unfrequent. Lay the masts on the deck abreast their respective lower masts ; heels aft, and lightning conductors upwards.

Reeve the mast ropes from the deck through lubber's hole, either through a block or cheek on the after side of the cap, through the mast hole, down before all on that side of the lower stay on which the top-gallant mast is ; reeve it then through the lizard, downwards through the sheave hole ; take two half hitches with the end of the lizard through the royal sheave hole, or burn out a hole 18 inches below it aslant through the mast, and reeve the lizard through this. But whichever way it be done, there will be frequent mishaps unless two good hitches are taken with the lizard: send the end of the mast rope up on the same side of the stay through the mast hole, and make it well fast to *the foremost bolt in* the top-mast cap on the opposite side.

Main Top-gallant Masts are usually cut with the live sheave

aft on the starboard side, fore on the port side; but top-gallant masts are sometimes *converted* spars, and, unless inspected, there may occur a cross in the mast rope.

TOP-GALLANT RIGGING.

The Eyes are seized in the bight, stay spliced in. With fore-top-gallant mast, put the stay *first* over the funnel, then flying jib-stay, flying jib-halyard block, starboard shrouds, port shrouds, and backstays: the others, excepting the jib stay and block, are rigged in like manner. Sway the mast up until the head has well entered the mast hole, then mark the mast rope at the bitts with a piece of bunting through the strands; cast off the lizard. If the rigging has not been placed on the funnel aloft, send it up abaft with a mast head gantline bent on below the seizings, and stopped to the funnel; place the funnel on the cap over the round hole, and enter the mast head to steady it. If the royal rigging goes on a funnel, send it up the same way, and fix it on the royal mast head. Ship the truck, reeve signal halyards, sway the mast, reeving royal halyards and lifts; settle the top-gallant funnel in its place, and when the sheave is above the cap, reeve the top-gallant yard rope. Lash the span blocks for top-gallant studding sail halyards, send the stays down before all, score the rigging in the cross-trees, and reeve it through the rail hoops, and the top-gallant lifts through the thimbles in the shrouds. Lash on the Jacob's ladder abaft all, and fid the mast; steady up the stay at once, for as it is underneath, we do not wait for the rigging eyes to be pulled down. Connect the ends of the shrouds in the tops with a long splice, seize a double block in this bight, reeve a tackle, and set up the rigging. In sending top-gallant masts up whilst rolling, these tackles are carefully attended.

Royal funnels are not "supplied," but are frequently made on board. Sometimes, a projection from the upper edge goes through the truck, and is secured there by a nut on top.

Another way for Royal Rigging is to have the rigging and truck placed on a piece of wood exactly similar to the mast head itself above the sheave hole, cut out underneath, and into which cutting the mast head enters.

Care must be taken here that the conductor be reached by the *spindle.*

There is usually a Grummet put on the mast under the lower edge of the funnel. Some top-gallant masts, as well as top-masts, have a metal rack on the fore side of the heel, with a paul on a bolster, which stands across the tressles; this serves to bring the mast up in the event of the mast ropes carrying away.

Top-gallant Mast Ropes should be frequently surveyed, the nip at the standing part freshened, the rope turned end for end, and worn places cut out. When the mast is sent down, the mast rope is parcelled in the wake of the top rim; and when the masts are up, *all the lightning conductor plates on the caps must be placed in connection.*

The Fore-top-gallant Stay passes over a score on the jib-boom end; the Fore-royal Stay over one on the flying boom-end. Both these reeve through a sheave in the dolphin-striker, and set up in the head.

The Main-top-gallant and Royal Stay are sometimes brought to the fore cap; but usually the top-gallant only; the royal reeving through a hole in the after fore-top-mast cross tree. Mizen-top-gallant stay is brought to main-top; mizen-royal to main cap.

Nothing is so common in the chapter of accidents as misfortunes with top-gallant masts; and nothing is easier than to burn out a hole through the mast, athwart it, a little below the lower side of the top-mast cap when the mast is fidded. Have an eye bolt, with a lanyard spliced into it, kept constantly at the top-mast head. Splice the end of the lanyard round a shroud that it may never be mislaid. Always keep it in the hole until the fid is out, and enter it when the mast is going up the instant the hole appears above the tressle trees.

TRY-SAIL MASTS.

All *ships* have a main and mizen try-sail mast, and some have a fore.

Brigs have no main: some have a fore.

They are coppered for the greater part down; the after sides have hoops for the sails rove on them, and are stept with their heads through a hole in the top. Their heel rests either on the deck, or in a crutch on the mast hoops.

LOWER SLINGS

Are chain straps round the lower masts' heads, to which the

lower yards are hung. The after parts are cleated up clear of the rigging eyes, and the foremost hang down through holes cut in the fore part of the tops amidships, before the foremost cross-trees.

There is a slip in the foremost end by which the slings on the yard are connected.

Jeer blocks at the mast head are double or treble according to size of ship, double strapped with lashing eyes, which, after passing through holes in the tops, are secured abaft the lower mast head.

THE JIB BOOM.

Is pointed over the knight-heads: a whip on the fore stay takes it into its place on the bowsprit, with the end pointed through the cap hole lightning conductor downwards.

The heel rope is rove through a block at the cap inside the stays, through the sheave hole in the heel of the boom, and hitched to the other cap bolt.

The *Jib Traveller* is then put on: then the foot ropes, then the martingale, guys, and flying boom iron. The dolphin striker is slung near the cap; and the sprit-sail gaffs near the rigging by "jaw ropes," and supported at their ends by lifts from the bowsprit cap. The lower eye of the martingale and eyes of the back ropes are placed on the lower end of the dolphin striker, and the eyes of the guys over the ends of the gaffs. The fore top-sail tackle or jib halyards are made fast to the outer end of the boom, which—keeping as much strain on them as will keep the heel down from rising off the saddle—is rigged out by the heel rope: the "heel chain" is scored in the heel; the "crupper chain" is scored in the notch, and both are secured by slips.

On pulling up the sprit-sail lifts and guys, the gaffs come nearly horizontal. The back ropes are steadied up, and the sail tackle removed.

The *Jib Stay* is rove through its hanks, through the sheave hole in the boom end, through another in the dolphin striker, and its end, which is pointed and "becketed," set up in the head.

The *Traveller* is supplied in case it should be thought desirable to bring the jib-stay and tack to it as in a cutter, setting the stay up by reeving it through a block at the mast

head, and fitting the end with a tackle on deck. In such case the traveller is worked by an outhauler through the sheave hole in the boom. The object of this kind of fitment is to admit of the jib being eased further in; but excepting for the second jib, it is now seldom employed.*

Small ships have *Whiskers*, iron out-riggers projecting from the cathead, instead of sprit-sail gaffs; through the ends of which the jib guys are rove, setting up in the fore chains, but clear of the anchor flukes.

The mere weight of jibboom rigging is very considerable, and when this gear is always kept taut, the spar is invariably badly warped.

When the jibboom is fitted with a funnel, it is very convenient to fix two iron projections on the fore part of the bowsprit cap, under the round hole outside; these serve to support the funnel exactly in a line with the hole whilst shifting the boom.

The Flying Jibboom is rigged out on the starboard side by a heel rope from the jibboom end; the heel steps in a cleating on the foreside of the bowsprit cap; the martingale reeves through the dolphin striker, the guys through the whiskers or gaffs, setting up in the head.

When the jib stay sets up on deck, make the standing part fast at the boom end by a slip, and when the jib is bent, make the tack fast round the boom with a strop and toggle; keep a short piece of rope spliced into the eye at the end of the stay, and in shifting or unbending the jib, after hauling the sail down, hitch this piece of rope taut to the stay above the hanks, knock off the slip, and haul in the sail and stay. As the out haul block remains at the boom end, the out hauler will carry the stay and new sail out. Another way is to reeve the end as usual through the jibboom and dolphin striker after passing it through the hanks. Make the downhaul block and tack of the sail fast to the boom end with a strop and toggle, but also lash them both so slackly to the stay above the sheave hole that the strop and toggle will bear the strain when the jib is set. To shift jib, send a man out, haul down, let go the stay and toggle, and the down haul will

* It is not customary to have jack stays on these booms; but they are easily seized on, and are of great service whilst stowing head sails in blowing weather.

bring the sail and stay in without a stoppage. The new sail is rove on the stay, the tack being seized to it as before, and hauled out by the reeving line; the bight of the halyards is passed round the sail near the tack to keep it off the bowsprit.

A ring bolt let in flush with the wood on top of the heel of the jibboom is convenient for handling the spar, as also are double stay-sail halyards for shifting it.

CHAP XI.

EQUIPMENT: RIGGING.

LOWER YARDS.

Boom Irons are easily broken, and if there is no jetty or other place to guy off to, rig the fish davits in the fore parts of the fore and main chains, on opposite sides. Lash the jeer blocks on the yards before launching, bring the yards alongside under the davits, having the proper yard-arms forward, as the case may be. Reeve three parts of the jeers, hoist the yards up with the fish to the bunts, taking through the slack of the jeers; guy the yards as square as possible when they are above the nettings; put off guys on the yards, to prevent the davits from canting inboard, overhaul the fish, ease in the off guys, and heave up the jeers. Land the yards on chocks in the nettings, and lash them. Lower yards are also got on board by stopping out the mast-head purchase, (whether jeers or hawser) on the fore-mast quarter; but the rising arm butts against every projection on the side, and generally staves in the hammock netting.

RIG LOWER YARDS.

The Jeer Blocks are single, double stropt, having long and short legs. The blocks stand fore and aft on top of the yards, and the strops are secured on the forequarters of the bunts of the yards with rose lashings. There are two such blocks on both the fore and *main yards*; the cross jack-yard is fitted with a

double iron stropt jeer block, which is pinned to a metal band on the yard.

The top sail sheet, or quarter blocks are single, double stropt, stand athwart ships under the yards outside the jeer strops, are lashed on top of the yards, and spanned together beneath them.

The *Truss Strops* come next; they are usually of rigging chain, double; with a thimble rove through the bight abaft the yard.

The *Clue garnet* blocks are single stropt, standing athwart ships outside the truss strops, underneath the yard, a little before the centre, so as to be clear of the topsail sheets.

The *Rolling tackle* strop is generally a grummet; a thimble is seized in it on top of the yard, and then it is driven taut up on the quarter.

Jackstays go on first over the yard-arms. The eyebolts on the yard are served with rope yarns, and the upper eyes of the *stirrup* are then placed over them; the jackstays are then rove through the eye-bolts, and are set up in the bunt of the yard.

Head-earing Strops are next put on.

Then the *Foot Ropes*, which, after being rove through the stirrups, are secured abaft the yard in the bunt. In large ships, it is very convenient to fit quarter foot ropes, which, crossing the bunt from each quarter, enable the men to get a footing on that part of the yard. Flemish horses, also, at the yard arms (as in topsail yards) facilitate reefing courses.

Then the *Yard tackle pendants*, the splice being placed *under* the yard. The pendants are brought taut along the yard, by tricing lines which are rove through cheeks on the after side of the yard; and it is useful to fit a strop and toggle round the yard and pendant close to the block, so that the yard tackle may be worked from that point when necessary.

Then the *Brace Blocks*. The yard arm strops are single; those on the blocks are double, so that the blocks may lie horizontal. For greater ease in bracing up, the largest blocks on the main yard are placed on the fore side, and all the pins must be square ends upwards.

Lastly, Lift Blocks; these are single, and single stropt.

The Leech line and *Slab line Blocks* are seized to the jack-

stay for a full due, when, on bending sails, their proper position is determined.

The *Slings* are double chain strops, which, being passed round the yards between the jeer strops, are rove through their own bight. There are large links in the upper bights through which, when the yards are up in their places, the tongues of the mast-head sling slips are passed and secured.

Turk's-head all foot ropes on each side of the stirrups; otherwise, when the yards are manned, the men of light weight will be thrown too high, whilst those who are heavy will scarcely be able to reach over the yards. Moreover, if a foot rope carries away, which sometimes happens when the men are *tossing up*, they will be greatly endangered.

The *Fore yard* is rigged just as the main, excepting that there are no brace blocks on the fore side.

The *Cross jack yard* is fitted with truss strops, lifts, brace blocks, jack-stay, and foot ropes; there are generally iron bands, to which the slings and topsail sheet blocks are connected. In some cases, the topsail sheets are rove through one double block in the bunt of the yard underneath, reaching the deck on their opposite sides. In this way, the yard braces up easier.

Cheeks, having sheaves nailed on the after side of lower yard-arms, are very useful for whips or reef burtons.

TOPSAIL YARDS.

Hoist the topsail yards in, with reference to the yard-arm that is to be forward in going up. Try all the boom irons and tie blocks to both sets, and mark corresponding notches on all parts with a cold chisel.

The *Main Topsail Yard* is fitted with two iron bands, to which iron-bound swivel tie blocks are connected by a bolt and fore-lock. The bolt ends are covered with a piece of leather, and the edges of the iron strapping smoothed down, so as to preserve the mast from chafe. Tie blocks and boom irons are to be tried to spare yards before sending them aloft.

The *Parrel* is to the yard what the traveller is in a boat. It is made of two pieces of rope, which are wormed, parcelled and served; *one piece being longer* than the other: the four ends have

eyes spliced in; the short is placed on top of the long leg, its ends being equally distant from those of the other. They are then marled together, covered with leather, and seized together at the short ends. The Parrel, when in use, is placed abaft the mast, with the seam of the leather outside; the long ends are passed round the yard from underneath, and are lashed to the short ones; and a greasy mat is secured to the yard between it and the mast.

The *Quarter Blocks* are double, single strop, lashing eye, and put on outside the parrel.

The *Rolling tackle strop, Served eye bolts, head earrings, jack-stay, stirrups, foot ropes, lift and brace,* as before mentioned.*

The *Flemish horse* is a yard-arm foot rope, reaching from the neck of the boom iron to the outer quarter of the yard. It is put on after the lift.

The *Brace blocks* and *Yard strops* are double ; the block thus standing edgeways.

Preventer brace pendants are very convenient fitments, the double whip being put on without risk or delay.

Topsail lifts are both double and single : the former kind, after reeving through the sister blocks, are rove through blocks at the yard-arms which go on outside all the other rigging : the ends are secured at the mast-head. With single lifts, the end goes with a spliced eye over the yard-arm. The double lifts relieve the sister blocks and top-mast rigging of much strain.

The *Cheeks* for the top-gallant sheets are scored out as snatches, so that the bight of those sheets may be thrown out, instead of unreeving the end when about to send the yard down.

The *Foretop-sail* yard is rigged as the main. In the case of the *mizen*, the Flemish horse is spliced into an eyebolt at the yard-arm, and the brace blocks face forward.

With *Top-gallant yards* the jack stays are kept in place by means of leather beckets, which are nailed on top of the yard, their ends setting up in the bunt. The parrels are fitted with lashing eyes. The foot ropes set up on opposite quarters. A

* *Topsail yards*, fitted for Becket topsails, sometimes have two jack-stays; *so that by having* two rows of toggles the reef points may be more clear of *each other when* there are two or more reefs in.

grummet-strop is worked on each quarter, in which a thimble is seized. Through this the lizard is rove when the yard rope is stopped out. The yard-arms are generally fitted with snatch cheeks for the royal sheets, and the earring of the sail when bent is passed through the sheave hole.

Quarter blocks are double, the strops being fitted with lashing eyes; but as these yards are so frequently sent up and down, it is usual to fit strops on the yard, to which the quarter-blocks are hooked or shackled, the blocks remaining at the mast-head when the yards are down.

Slings, to which the yard ropes may be bent without opening out the sails, are also convenient.

The *Lifts* are single, having an eye splice which goes over the yard-arm.

The *Braces* are fitted either double, or single with whips on the ends.

Royal yards are fitted with jack stays, foot-ropes, lizard strops, quarter blocks, parrels, as are top-gallant yards.

The eye bolts in the arm ends of these yards are generally removed, the jewel blocks being fitted with strops, which go over the yard-arms, and the tripping lines are bent to the foot ropes.

REEVING RUNNING RIGGING.

In reeving *Running gear*, as the difference of length in ships of the same class occasionally causes the establishment to run short, it is safest, and, generally speaking, most economical to "reeve and cut."

Pass the end down through the coil before hauling it off. Brace all the yards about; overhaul yard tackles well down; run the topsail yards up for clue lines; take a good stretching pull, and leave a long enough end before cutting.

The ends of the *jeers*, being fitted with beckets, are taken three times round the capstans, then passed through leading blocks and holes in the deck and rove, beginning aloft from aft forward; then either hitched round the yards, or, what is better, to strops on the yards for the purpose.

The *Main preventer braces* reeve through blocks on the fore-mast under *the tressle-trees*, and are frequently crossed, not only

to give the brace a greater angle in bracing up, but also that one order for lee or weather braces may suffice; and also that in tacking, the main-brace men may stand clear of the main-tack men.

The *After main braces* have a tackle on the standing part, the hauling end reeving through a leading block on the quarter. Both parts are rove through the cringles of tricing lines, so that the lee ones may be triced up clear of the quarter davits, &c.

The *Fore braces* are led from the main bitts through leading blocks on the main-mast under the tressle-trees, through the brace blocks, and then made fast alongside the leading blocks. It is well to fit these also with tricing lines from the main stay on the shifting main topsail yard side, so as to be able to frap the brace in whilst shifting.

Cross jack braces lead to the main-mast, and for the same reason given for the main, are frequently crossed. When so, the leading blocks should run very freely, so that the lee brace may not girt the trysail when set. These braces have been led aft to the poop of large ships with great advantage in manœuvring. For there is always more trouble in getting a ship *off* the wind than *to* it, and more risk incurred generally in bearing up than otherwise. A ship will often hang with the wind abeam, and the helm hard up, to a dangerous extent, when a ready touch of the after braces, and tack tricing line, (which may be given by the quarter master and signal man,) would release the ship from her balance.

The *Fore and main lifts* are rove from the deck through the *foremost* sheave of the cap lift block first, then rove full, the end being fast round the yard-arm with a running eye; but it is best to clench the end, leaving about two or more fathom spare in lieu of topsail sheet stoppers.

The *Cross-jack lifts* are single, being either rove through cap blocks, or passed over a saddle which is scored out on top of the cap.

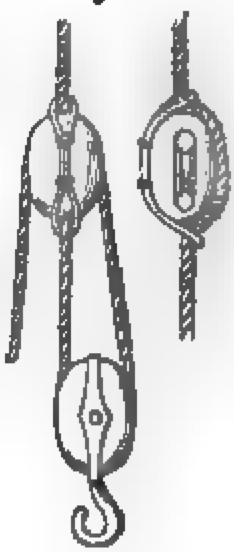
HEAVING UP LOWER YARDS.

The fore bowlines are bent to the fore yard; these, as well as the preventer main, and cross jack braces and lifts, are

attended, so as to keep the yards off the masts, and steady. The after main braces are overhauled, and triced up, the capstan bars are shipped and *swifted**, the pauls let down *against* the "walk back" turn, and care being taken to stop heaving in time, so as not to split the jeer blocks by heaving them together, the yards are hove up. A few hands on the lifts will keep the yard square whilst going up, and thus lighten the heave; for the least tilt woods the sheaves, and thereby increases friction very considerably.

Connect the slips, lash the tongues with good spun yarn, mark the jeers for future service, walk back; and when the slings have got the weight, unreeve the jeer falls, and reeve the short ones, which are in fact preventer slings, and should never be dispensed with. The "Britannia," for one instance among many, carried away her chain main yard slings twice during her last commission, the yard being brought up each time by the preventers.

Fig. 92.



The hauling ends of the lower lifts are fitted with a purchase which must be moveable, on account of striking the yards; and none seem to be more approved of than as in the sketch, *fig.* 92., the end itself composing the tackle.

TRUSSES.

Trusses are either of chain or rope as preferred. The standing ends are rove through the thimbles in the strops on the yards, crossed abaft the masts above the futtock rigging, and made fast to the quarters of the yards; the hauling ends are pulled up by tackles from the after ends of the tressle-trees. There is one of these pendants on each side of the fore and main yards; but the cross jack yard has only one, both ends of which reeve through thimbles on the yard, and are set up with tackles as above mentioned. The eyes of these pendants, when of rope, are

* It is not necessary to say more, than that great disasters have occurred from neglecting the use of the swifter and paul, and it is well to remember that no *small* accident can happen with a capstan.

made Flemish pattern, so as to unreeve whilst striking lower yards.

The most approved fitment is to have the thimbles on the yard connected to the truss strop by a shackle, and thus without unreeving any gear, the whole fitment, whether of chain or rope may be disconnected. The pendants are kept up in a line with the yard, by means of thumb cleats, on the after part of the mast.

In fitting this gear for the first time, the yards must be moved sharp up, before cutting the rope or chain.

The pendants are kept well greased; rope ones necessitate whips for the purpose of overhauling them; chain ones overhaul their own weight so completely on being let go, that the yard hangs at once, pivoting on the slings.

LIFTS AND BRACES.

The *Fore topsail braces* are rove from the main bitts, through leading blocks under the main tressle-trees, then through others on the fork of the main stay, through the yard-arm blocks, and up to the main top-mast head, where they are made fast. The leads on the stay serve to keep them clear of the foot of the main topsail.

The *Main topsail braces* are rove from the mizen bitts, through leading blocks on the mizen mast, then through the yard blocks, and up to the mizen top-mast head, where they are made fast. The mizen top-mast is much relieved by carrying the ends through leads down to the after part of the mizen chain.*

The *Mizen topsail braces* go to the main cap and are led to the poop;

The *Top-gallant braces* to the top-mast heads;

The *Royal braces* to the top-gallant mast heads.

The *Mizen upper braces* lead variously to the main top.

In large ships, the top-gallant braces are double; the lift, brace, and top-gallant studding halyard block being marled together. Double braces are, however, inconvenient on account of the block, and a strong single brace, having a whip on it under the lead, seems to give sufficient purchase.

* Fitting the after mizen top-mast back stays with a runner and tackle, so as to set up the weather one well aft, also gives much support.

The *Topsail lifts* are rove from the deck through lubber's hole on each side, through the *lower* sheave of the sister blocks.

Top-gallant lifts are rove from the tops on each side, through thimbles which are seized into the top-gallant shrouds below the eye seizings, and go with an eye splice over the yard-arms.

The *Royal lifts* go from the tops in like manner, through thimbles in the royal rigging. In crossing upper yards, the work will be more quickly and neatly effected by having the lower lifts tailed and worked on deck. Moreover, the yards will be more readily squared, and the tops cleared.

TOP-SAIL HALYARDS.

The Topsail Halyards are runners and tackles, a fact worth remembering in the event of one being suddenly injured. The fore and main have one pair on each side, the mizen only one pair. One pair of the fore and main is fitted with double blocks above and single below, the others with singles only. The upper ones are the "*Fly-Blocks.*" The doubles are rove on opposite sides, and are used with the watch: the singles are also on opposite sides, and are used with the hands. The runner part is called the tie. The main is single on the starboard side; the fore and mizen are single on the port side, and these ties are cut long enough for the ends to reach the deck with a fathom to spare, when the fly-blocks are rounded close up: these ends are tapered and plaited. The ends of the double block ties are cut long enough merely to hitch round the top-mast head, when the fly-blocks are square above the lower caps, and the yards are on the caps. The single fly-blocks are triced up when doubling the tie with a whip on the back-stay.

CROSSING TOPSAIL YARDS.

To send topsail yards up. Lay the main on the starboard side of the deck with its port yard-arm forward: the fore and mizen on the port sides with their starboard yard-arms forward.* The foremost yard-arms will thus be the upper ones. Hook the

* If there are davit topping lifts the mizen-top yard will go up best with its upper arm *aft*.

sail tackles to the strops on the upper quarters of the yards; round the long tie halyards close up, and hitch the ends of their ties taut through the tie block next the lower yard-arm.

Let the sail tackles and ties be outside of the lower stays, and in the case of the main outside of the fore brace. It is well to fit a frapping on both parts of the fore brace with large hanks; the line being led through a block on the main stay, gathers the brace in on such occasions. Take the boom irons off, and have chocks fitted for the lower yard-arm irons to step in. Lead the sail tackle falls on the main deck, and by working the long tie falls on their own sides, there will not be any one under the yards. Sway up and down, bearing the lower yard-arms amidships as the upper ones rise from the deck; and the latter will not butt against the top. When up and down, bear the lower yard-arms forward, that the men in the tops may work close to the upper yard-arm: put on the brace blocks, lifts, Flemish horse, jewel blocks, and boom irons; the lower lifts should be tailed with a piece of strong rope long enough to lead in board a couple of fathoms through a block in the chains; sway away. When the bunts of the yards are just above the caps, if the upper yard-arms are clear of the cross-trees, ease up the sail tackle, pull up the lower lifts, gather down the braces, tautening the fore and main. Parrel the yards. Reeve the short ties, make them fast, haul them taut, and belay. Then let go the long ties, round up their fly-blocks, carry their ends to the mast head, square the fly-blocks, and secure the standing parts of the long ties by passing the *bights* round the mast-heads, seizing them to their own parts. Then clench their ends round the standing parts, ready for shifting yards, taking care that when the bights are cast off, and the clenches run down to the tie blocks, there will be drift enough for pulling up the long tie halyards.

The weight of topsail yards is always kept off the caps by keeping the lifts at a certain length. This should suggest the absolute necessity for hauling the topsail halyards taut, and belaying them when the yards are lowered; especially before sending men on the yard to reef or furl.

In squaring yards, get them amidships first of all. When the *pipe from the boat* that may be ahead persists in "Top away," *and the lift on the* side denoted is very taut, answer the pipe

"top away," but check the opposite lift. A contradictory order will be avoided, and a rope saved.

The upper yards should be squared first, because we may then pipe down from aloft, and square the others from the deck.

The topsail fly-blocks are secured to hanks which run on jack-stays, in a line with the halyards, so that, should the halyards carry away, the tackle may be carried over the side, clear of the deck.

UPPER YARDS.

The top-gallant and royal yard ropes are bent to the top-gallant and royal yards, after being rove through the grummets and lizards, and the yards are left suspended by them so as to let them stretch and take the turns out.

When not across, the royal yards are usually kept in fine weather in the top-mast rigging, and the top-gallant yards in the lower rigging. With the latter, the lower yard-arms enter into beckets on the shrouds, and the upper are stopped in the same shroud; thus, one shroud bears the whole weight of a top-gallant yard, which, with its sail when wet, is something considerable. To instance the dangerous nature of this mode. Sending top-gallant masts and yards down in a certain ship, the top-gallant yard was lowered, the lower yard-arm (apparently from the lowering place) caught in the becket, and the upper arm stopped in; the yard rope was let go, and a smart top-man employed in the fore part of the top, unreeving it. It turned out that the lower arm had only rested on the outer edge of the hammock netting, and there it *might* have remained; but a man running down the rigging shook it, so that the lower arm slipped off, and down. The upper arm being released, fell inwards, glancing the lower one off out of the chains: the yard shot overboard, whipping the yard-rope and topman out of the top and killing him on the spot.

The fashion of "up and down the lower masts" is now prevalent. The lower yard-arm steps in a shoe, and the upper is confined to the lower mast by a grummet with a line rove through an eye bolt in the mast batten: this grummet is slipped off by a line from aloft.

SPANKER-BOOM AND GAFF.

The jaws of the boom rest on a saddle, which is secured to the mizen trysail mast, with cleats and clasp hoop. The gaff works on the same mast; both gaff and boom have "jaw ropes;" that of the former has "trucks" on it.

The boom rests in a crutch on the taffrail when not in use, but when required it is lifted and supported by double "topping lifts." These are differently fitted; in some, the tackles are on the end of the lifts, the lower blocks hooking on to the boom with the falls, led through snatches on the side of the boom. In others the lifts lead through the snatches; one tackle is led along under the boom, and hooked on to the weather lift; when that becomes the lee one, it is stopped and the tackle shifted.

In others the end is brought down to the chains or side, and set up there with a tackle. The bights are rove through iron-stropt clump blocks hooked on to the boom. The lifts reeve at the tressle-trees, either through a clump block or cheeks.

The *Boom sheets* are rove through double blocks on each side of the boom and quarter; the standing part in ships being spliced into an eye bolt at the boom end, and the hauling part led through a sheave or leading block at the ship's side.

The *Throat halyards* are rove through a double block or chock at the mast-head and single hook block below, round the strop of which the standing part is hitched.

The *Peak halyards* are rove in ships through a double iron-stropt block at the mizen cap, and two such singles on the gaff about one third from the end; the standing part is rove last through the *foremost of these blocks*, and made fast at the mast-head.

The *Vangs* or *peak downhaul* are two single whips on the after end of the gaff, and brought to each quarter.*

The *Throat downhauls* are similar whips on the jaws of the gaff, and are led amidships.

The *Outhauler* is led through a sheave at the boom end through a "clump," with either a lashing eye or a "clip hook" in it, and made fast at the boom end, or rove through another sheave, and a tackle put on its end.

* *If these* are put on at the outer peak halyard block strop, no harm will befall *the gaff if the* vangs are foul when swaying the peak up in the dark.

The *brails*, inner and outer, are led through blocks at the under side of the jaws of the gaff, through cheeks or blocks on the gaff to the after leech of the sail. The *Throat brails* are led from blocks at the jaws, straight to the after leech; and the foot brails are led from blocks, seized on to a span half way down the trysail mast; to the after leech. These brails are each in one piece of rope, and when the sail is bent and hauled up, the position for the brail is ascertained, and its bight seized on the after leech.

The *Throat and peak brails* should bring as much of the leech as the length of the head of the sail taut along the gaff when hauled up.

Boom mainsails have no brails. The sheet is a fixture, and the sail is worked by the halyards, downhauls, and reef pendants.

The *Trysail* gaff is like the other, but much smaller.

The *Signal halyards* are two small single whips at the outermost point of the gaff, brought to each quarter in harbour, and are hitched *to the boom* when it is in use.

Peak halyard blocks are most readily shifted if hooked inwards.

Jack stays on the after ends of spanker booms are most necessary, but not usual, although perfectly unobjectionable.

RUNNING RIGGING.

The *Jib halyards* are single rove from aft through a block at the fore-top-mast head. The sail is bent to the stay with *hanks*. The downhaul is rove from the forecastle through a block at the jib-boom end, then through the hanks and hitched round the bend of the halyards. The sheets are double whips with pendants, which are made with an eye in the bight, that is connected with the clue by a strop and toggle.

The *Flying jib halyards* are single rove from aft through a block at the fore-top-gallant-mast head. The sail is bent to the stay with hanks; the downhaul is rove from the forecastle through a block at the flying boom end; then through the hanks, and made fast round the bend of the halyards.

The *Fore-top-mast stay*sail halyards are single rove from aft through a block at the fore-top-mast head; the sail is bent to the stay with hanks; the downhaul is rove from the forecastle through

a block at the bowsprit end, through the hanks, and made fast round the bend of the halyards. By reeving these halyards double, they become useful for shifting the fore-topsail, or the jib-boom.

For convenience in stowage, lacings are substituted for hanks at the lower part of the luff of the head sails. A good lead may be found for jib and staysail halyards, by connecting the foremost leg of the fore-top-mast cross-tree with the tressle-trees by eye bolts, in lieu of those which are clenched on each side. The eye bolt, being driven from underneath, is clenched or forelocked on top, and the halyard blocks are stropt into the eyes.

The *Main-top-mast staysail* runs with hanks on the lower top-mast stay, and is usually fitted with brails as well as downhaul.

The *Top-gallant and royal staysails* have stays, which are triced up along with the sails.

The *Main staysail* is fitted with beckets or grummets, and works on a stay which is rigged for the purpose of setting it.

The *Fore staysail* runs with beckets or grummets on a stay of its own, which is unrove in settled fine weather. The halyards are a double whip, and the sheets luff with the hooks well moused. Downhaul reeves through the beckets to the head.

The *Second jib* runs also on a stay of its own which is made fast to the traveller, setting up at the mast-head or on deck. It is set occasionally when the jib cannot be carried, by hauling the traveller out half way on the boom, and hoisting with jib halyards. The down haulblock is fast to the traveller, and the jib sheets to the clue.

A tackle from a strop at the traveller to the dolphin striker, set up before the stay admits of carrying on without "buckling" the boom.

The *Courses* are hauled down forwards by tacks which are of tapered rope rove double through clump blocks at the clues of the sails. They are hauled down aft on each side by sheets which are also tapered.

These clumps are connected with the clue either by separate lashings, or by shackles rove through the clue and eyes of the blocks, one shackle uniting one clue with two blocks. When so, *the bolt should* be a screw with a nut. This remark will apply to *the topsail sheets* when thus fitted, and the condition of these

fastenings should be a subject for report at evening muster or morning overhaul.

The sail is hauled up at the clues by the clue garnets. They are rove from the deck on each side, through the blocks on the inner quarter of the yard, through blocks lashed at the clues, and then made fast round the quarter of the yards with timber hitches. At the foot by buntlines, which are differently fitted. When there is drift enough, they are rove with single legs and double whips ; one leg and one whip on each side of each course. The ends of the legs are rove through thimbles spliced into the inner holes at the foot of the sails, and made fast at the outer holes. Others are whips with two legs made as a span.

At the sides by *leechlines*. These ropes are led from the deck through blocks hung under the after and fore part of the tops on each side, through those on the outer part of the yard, led down before the sails and bent to cringles in the leech. The slab lines are led from the bunt of the yards through blocks on the outer part of the yards, led down abaft the sails, and bent to the leech line cringles. The leech and slab line blocks are so placed on the yards, that when the course is hauled up, the leech of the sail is hauled taut along the yard from the yard-arm.

When *leech* or *bunt lines* are double, they are usually a *span*, having a block on the bight; the block of the whip is connected with the span block by a strop seized in between both ; but as such fitments are liable to take turns, it is best to put a swivel between these blocks.

Main Buntlines are generally led aft, over the *topping lifts*. Thus, in hauling up the main-sail, the men are not only more under inspection, but turning round from the clue garnets to the buntlines, they keep up such a continuous run that the sail may be carried to the last moment when necessary.

The *Fore Bowlines* are rove from the forecastle, through blocks at the fore stay on each side, and are toggled to bridles in the leech of the fore-sail. The main bowline is a light runner and tackle reaching from the fore-mast ; it is connected with the bridle on the luff of the main-sail when it is set, by a slip toggle.

The *Reef Pendants* are rove through clump blocks at the lower yard-arms, through similar ones on the leech of the sail at *the reef band, and* made fast to the boom iron. Fit these blocks

on the sail with clip hooks, tail the hauling ends of the pendants, carry these ends through leading blocks at the caps and bring them on deck; then taper them from thence with a lighter piece of rope and cut them long enough to admit of lowering the sail from the yard-arm by this rope from the deck: thus, in reefing and bending, the cumbersome burton will be dispensed with.

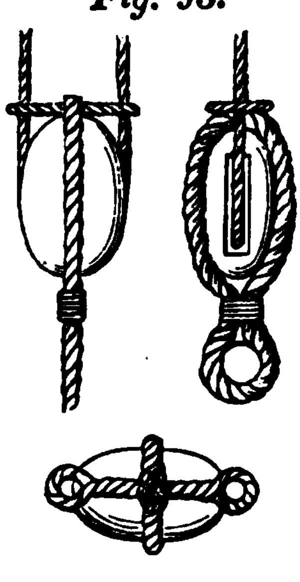
The *Topsails* are hauled down at the clues to the lower yard-arms by sheets. These ropes are rove from the deck through the quarter blocks on the lower yards, then through the cheeks at the yard-arms, then through the sheet blocks on the clues, and then are clenched at the yard-arms.

They are hauled up at the clues by the *cluelines.* These ropes are led from the deck through lubbers' hole; through the quarter blocks on the topsail yards; through the clueline blocks at the clues of the sails; and then hitched round the quarters of the topsail yards.

At the foot by *Buntlines.* These ropes are led from the deck through lubbers' hole, through blocks or cheeks at the top-mast heads, passed through the thimbles of the *span* before all, and are toggled to the foot of the sails.

The object of the span is to girt the foot of the sail amidships when hauled up.

Fig. 93.



At the sides by *reef tackles.* These ropes are led from the deck through lubbers' hole, through the upper sheaves of the sister blocks, then through the sheave holes in the yard-arm, then through the reef tackle blocks, which are made fast to the leeches of the sails below the reef bands, and then are clenched to the neck of the boom irons.

Reef Tackle Blocks occasion trouble at times by the earrings and reef points getting into them. Seize two round thimbles into the bights of grummet strop. Score the top of the block out in a line with the sheave; lay the middle of the grummet in this score, then strop the block as usual. Reeve the tackles through the thimbles, and they will never be fouled.

Topsail Cluelines are sometimes fitted with whips and pendants. The advantage here is, that they are never fouled by

reef points; but in having the pull so far from the work, there is a loss of purchase.

Both of these arrangements act indifferently as downhauls when braced up; for the lee ones cannot be used at all on account of the nip round the lee rigging and the weather ones bear all the strain. Moreover if the parrel goes, or the yard be brokent the clues must remain sheeted home.

They are also fitted by taking the quarter block, and standing parts to the lower caps; having downhaul tackles on the yards. The advantage here is, that after having clewed up, the clueline is done with; for nothing of it is lost in lowering the yard. Also, the power is nearer its work. The hoist is lighter; for the downhaul is more readily overhauled in hoisting than are cluelines in any other form. The clues are safer in shifting the yard; or, when the yard is sprung, the yard itself is more quickly shifted, there being no clue quarter blocks to cast loose. It takes less rope, and the downhaul is a more efficient downhaul than are the cluelines. They are, however, being unusual, apt to be neglected whilst about to hoist.

The *Top-gallant Sails* are spread at the foot by sheets. These ropes are led from the deck through lubbers' hole, through the quarter blocks on the topsail yards, through the cheeks at the yard-arms, and made fast with a strap and toggle to the clue of the sail.

They are hauled up by *Cluelines*. These ropes are led from the deck through lubbers' hole; through the quarter blocks on the top-gallant yards, and made fast to the clue of the sails.

Top-gallant Buntlines are not always fitted; but in large ships these as well as inner reef tackles on the top sail yards are indispensably necessary. There are no reef lines, or points in the top-gallant sail which may be grasped; and buntlines forward work, besides dispensing with those great efforts aloft which are always attended with unnecessary risk of life.

The *Royals* are spread at the foot by sheets. These ropes are led from the deck through lubbers' hole, through the quarter blocks on the top-gallant yards, through sheave holes or snatches on the top-gallant yard-arms, and are made fast to the clues of the sails. They are hauled up by cluelines; these ropes are led from the deck as most convenient, through the quarter

blocks on the royal yards, and then bent to the clues of the sails.

The *Fore-top bowlines* are led from the forecastle through blocks on the bowsprit end to the leeches of the fore-topsail. The fore-top-gallant bowlines are led from the forecastle through blocks on the jibboom end to the leeches of the top-gallant sail.

The *Maintop bowlines* are led from the deck through blocks at the fore-top to the leeches of the main-topsail. The main-top-gallant bowlines are led from the deck through blocks at the fore-top-mast head to the leeches of the main-top-gallant sail.

Studding sail booms are usually sent up by being slung with a *span*, and *when* the balance is correct, it answers; but the safest, easiest, and neatest way is to send the ends of the topsail buntlines down before all. Bend them to the heel lashing of the top-gallant stud booms. Mark these booms in the middle with a notch or copper nail. Splice a small piece of rope into the jack-stay on the topsail yard half the length of the boom from the yard-arm iron. Trice up and pass the end of the rope round the boom; haul it out and lower until the mark is at the place where the rope is fast. Take a turn with the rope *over* the yard, lower the buntline, and the boom will pivot horizontal, and may be entered in the iron without trouble.

Send the clue ropes down, making the upper blocks fast under the tops at the boom-jigger holes. Cross them and bend on to the inner ends of the top-mast stud booms. Bend the top-mast stud halyards on the *outer* ends about eight or ten feet from those ends. Trice up and the booms will lie along the lower yards; and if the points are outside of the outer irons, a pull on the clue ropes will bring them in, whilst a pull on the halyards will land them on the inner irons, upon which they may be rigged out. These evolutions may be performed together. When the booms are in place, clamp the irons and secure all the heels.

The *Top Stud Booms* are raised at the heels when necessary, by unclamping the inner irons, and pulling up *Jiggers* which are fitted for this purpose.

The *Top-gallant Stud Booms* are raised in like manner by *Tricing* lines.

The Studding-sail booms can'only be kept in their exact places *well, and all* equally rigged out, by splicing small pieces of rope —

distance lines — into their heels, and hitching the ends to the jack-stay bolts some six feet taut out. Moreover, as in quick reefing the top-gallant stud booms are not always toggled, these distance lines will, in the case of an omission, prevent an accident.

Lower studding sail booms pivot on goose necks at the fore chains. The outer arms are supported by *topping lifts*, which are led from the deck on each side through leading blocks under the fore-top abaft the fore-yard. The *fore guys* are led from the forecastle through blocks at the bowsprit end under the jib-guys, and are spliced into eyes on the boom strap. The after guys are led from the after part of the gangways, and are also spliced into the boom straps.

Fore guys have also been fitted double, with a block on the boom, both parts being led from the bowsprit through leading blocks on the whisker ends; the object being to dispense with the use of the lizard. The great spread thus obtained is convenient; but a lower studding-sail taken aback would endanger the jib-boom. When the booms are fore and aft, their after ends are supported by crutches on the sides; and the position of these crutches, as well as that of the rigging on the boom, is important as far as concerns the readiness of the sheet anchor. The iron hoop on the boom is easily moved further in or out.

There are also fitments in the main chains, in case it be thought desirable to set the lower studding-sail on the main-mast.

The studding-sail gear of the fore yard is gathered up to its quarters on each side by whips, called gear tricing-lines. The bights are stopt snug along the yard, and the ends taut up and down the fore rigging. It not only prevents delay, but saves the waist hammocks from being trodden down, if the ends of tacks and boom braces are tailed with small stuff, and stopt along the ridge ropes as far aft as the main rigging.

Lower studding-sail halyards are generally crossed in their lead abaft the fore-mast, so as to afford more working space when setting studding-sails on one side.

The *Fore lower stud-sails* are spread at the heads *outside* when the booms are out, by the outer halyards, which are led from the deck through lubbers' hole, through the upper sheaves of the fiddle blocks at the fore top-mast head, then rove before the boom *through blocks at the* top-mast stud boom end; and then bent to

the middle of the yards, to which the outer half of the heads of the sails are laced ; inside by light double whips called the *inner halyards*, which are led from the fore top rims to the inner corners of the head, and at the foot *outside*, by the tacks. These ropes are led from the after part of the gangways through blocks on the lower boom ends, and bent to the lower outer clue.

The inner corners are spread by the sheets.

They are taken in by the *tripping lines*, which are ropes led from the deck on each side, abaft the fore-yard, through blocks at the top rims; then through leading blocks at the inner arms of the studding-sail yards, and bent to the tacks of the sails.

The *Fore top-mast stud-sails* are spread at the head by halyards, which are rove from the deck through lubbers' hole through the span blocks at the top-mast cap before the yard, through the jewel block at the yard-arms, and bent to a yard to which the head of the sail is laced. At the foot they are spread outside by tacks; which are led from the main rigging through tack blocks on the boom ends, and bent to the outer clue. The inner corners are spread by the sheets; one being led from the deck, and the other from the top, passing under the heel of the boom.

They are taken in by *downhauls*, which are led from the deck before or abaft the boom, according to circumstances, through blocks on the tacks of the sails, through cringles on the leech, and bent to the outer arms of the studding-sail yards.

The *Fore top-mast stud booms* are supported by *topping lifts*, which lead from the fore-top through the lower sheaves of the fiddle blocks to the boom ends, and also by braces which lead from the main rigging.

The *Main top-mast stud-sail* is set in like manner, the tack being led aft to the quarter.

The *Top-gallant studding sails* are spread at the head by the halyards, which are led from the deck through lubbers' hole through the span blocks on the top-gallant mast head, passed before the yard through the jewel blocks on the top-gallant yard-arms, and bent to a yard to which the heads of the sails are laced.

At the foot outside they are spread by the tacks, which are led from the after part of the tops, under the topsail braces, through

blocks at the top-gallant stud boom ends, and bent to the outer lower clue; and at the inner by the sheets which are led over the topsail yard to the top.

They are taken in by a line from the top, which is bent to the inner arms of their yards.

The *Top-mast stud booms* are rigged in and out by a jigger led along the lower yard. When the booms are out, they are secured by a heel lashing to the quarter iron. Main top stud booms have no topping lift.

Tack and *lower halyard* blocks on top-mast stud booms are generally single stropped, and are thus very unyielding; the tack one especially so whilst hauling the sail down, thereby endangering the boom. They have been found to answer well when fitted with two strops, having thimble on thimble.

BLACKING DOWN.

When the rigging is in its place, advantage is taken of a warm day to rub it down with a mixture of two parts of vegetable to one of mineral tar. The thinner, or rather the hotter it is, the better.

If not prevented, petty officers will always send their fags about this work; and as such men are not aware of the consequences of hot weather, they use an unnecessary quantity, to the ultimate injury of decks, awnings, and white clothing.

" *Tar* is obtained by smouldering the heart-wood of the pine in stacks, nearly as in making charcoal, and collecting the sap in trenches. It is refined by heating it in an iron vessel to drain off the water and pyroligneous acid; and after a while pouring off the purer part, leaving the earthy residue.

" *Pitch* is made by boiling down tar, either by itself or with resin.

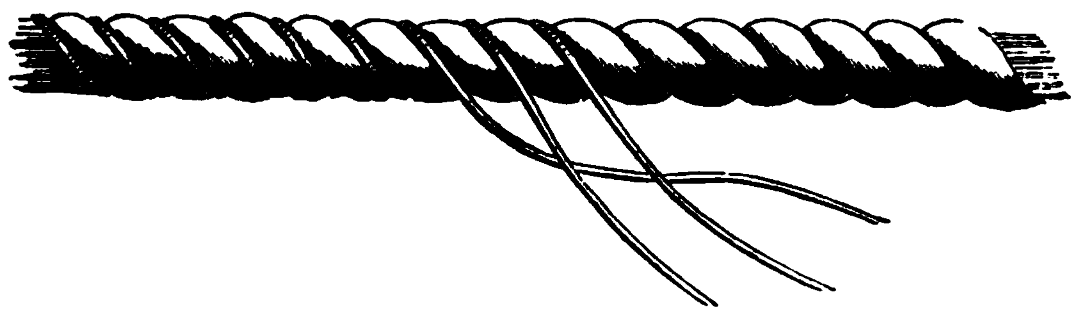
" *Turpentine* is the first running from resinous trees, such as pine; *resin* is the residue after obtaining spirits of turpentine by distillation from the raw produce."*

* U. S. Ordnance Manual.

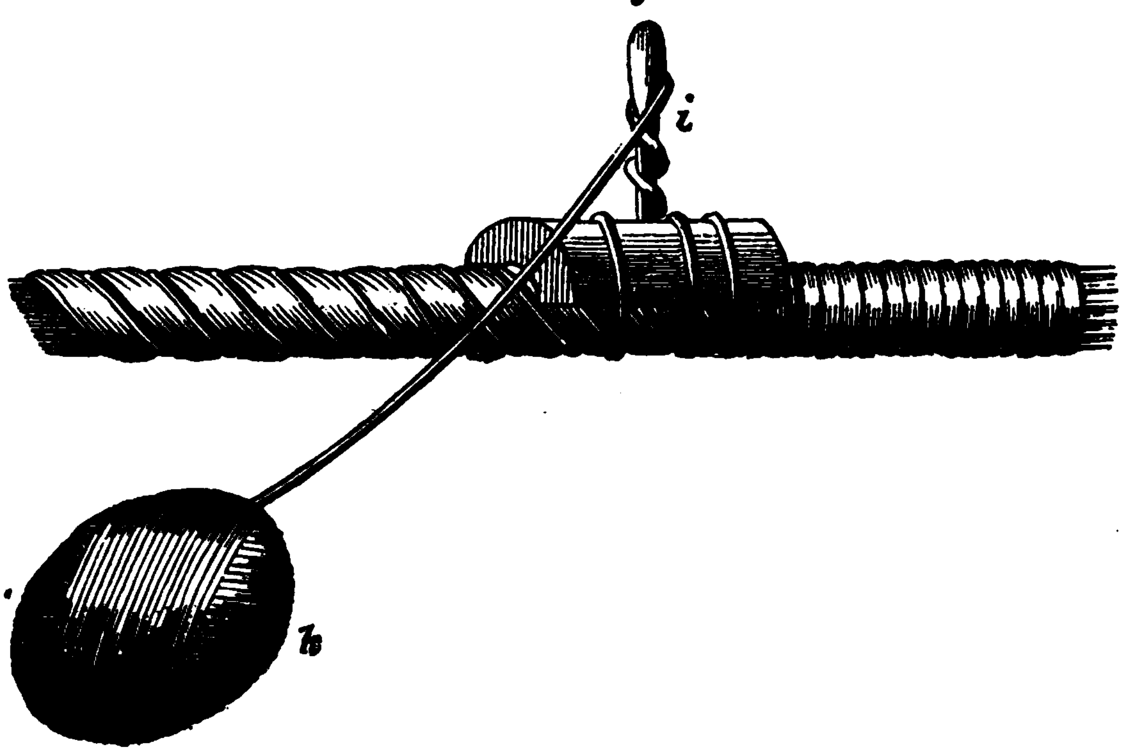
CHAP. XII.

KNOTS AND SPLICES.

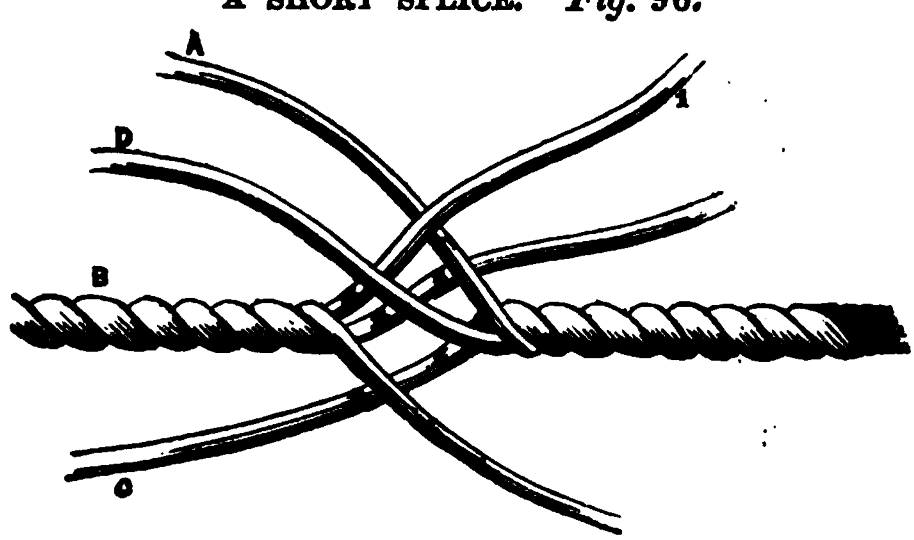
WORMING. *Fig.* 94.



SERVING. *Fig.* 95.



A SHORT SPLICE. *Fig.* 96.



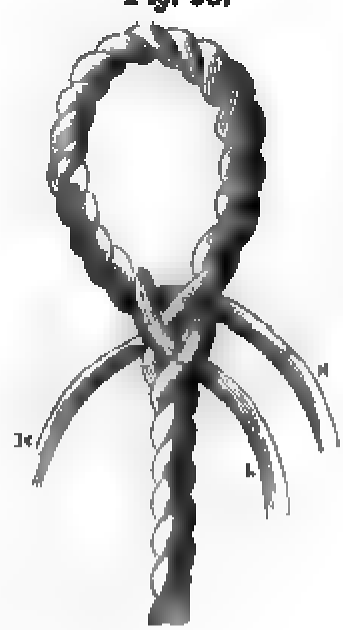
Unlay, and place the ends of the strands as in the sketch; hold the strands A D C (*fig.* 96.) and the end of the rope B fast in the left hand, or, if the rope be large, stop them down to it with a rope yarn: then take the middle end 1, pass it over the strand A and under C. Perform the same operation with the other ends, by passing them over the first next to them, and through under the second, on both sides, when the splice will appear thus:—

Fig. 97.

Repeat the operation, passing the ends over the third and under fourth; whip them and trim them off.

AN EYE SPLICE.

Fig. 98.

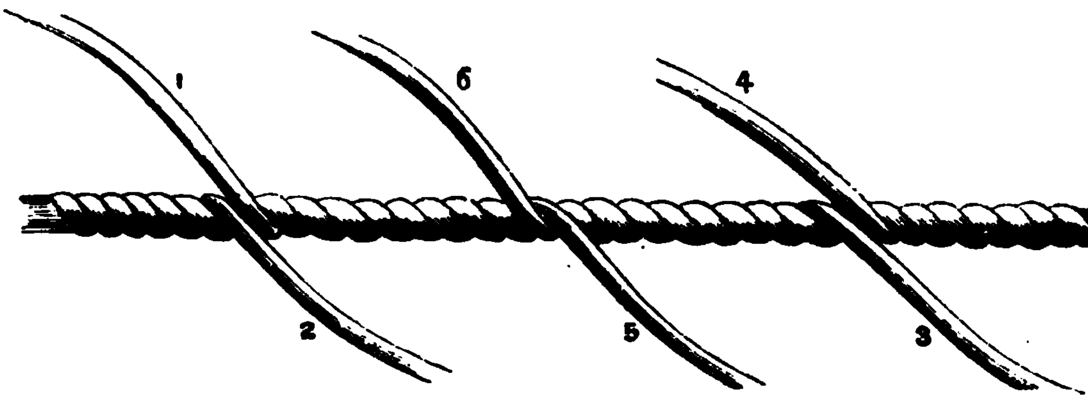


Open the strands, put the end H through the strand next to it; pass I over the same strand and through the second; and the end K through the third on the other side. (*Fig.* 98.)

A LONG SPLICE. (*Fig.* 99.)

Unlay the ends for some distance and place them as for a short splice. Unlay one strand (as 4.) for a considerable length, and replace it with its opposite one, 3. Then unlay 2, and replace it with 1. The middle strands, 5 and 6 are split; an overhand knot is made in the two opposite halves, and the ends led over the next strand and through the second, as the whole strands were in the short splice; the other two halves are cut off. The strands 3 and 4, and 2 and 1 are similarly disposed of.

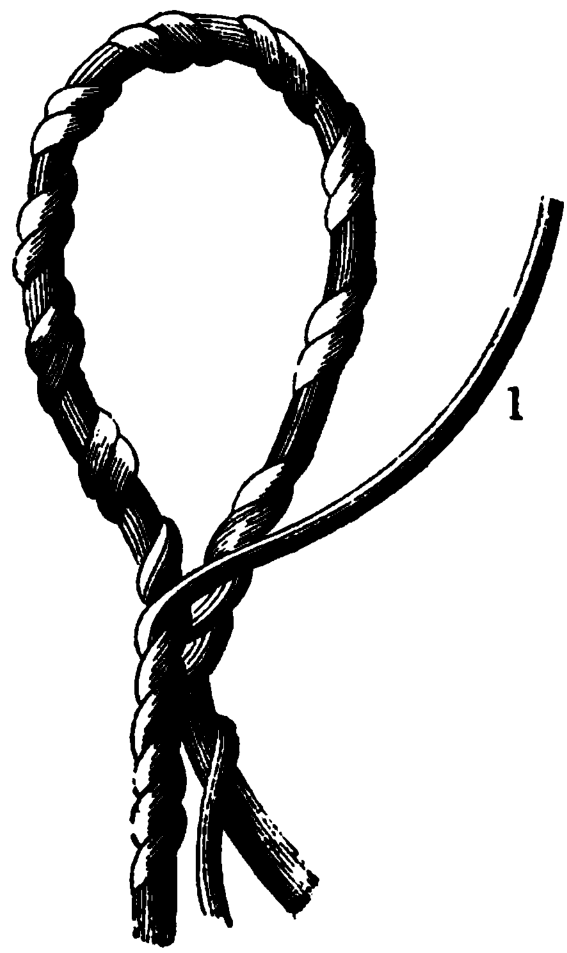
Fig. 99.



A FLEMISH EYE.

Unlay one strand of a rope, and form an eye by placing the two remaining strands along the standing part of the rope. Lay up strand 1. round the eye. Taper, marl, and serve all the ends down.

Fig. 100.



A CUT SPLICE.

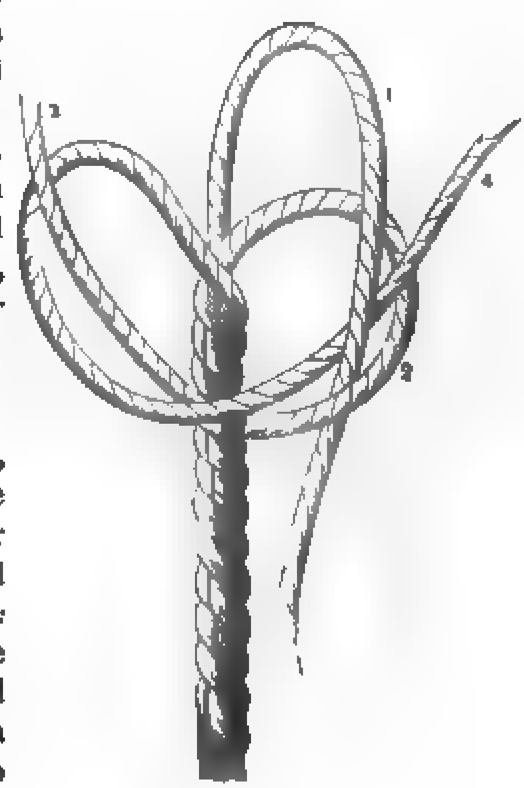
Cut a rope in two, and form an eye by splicing the ends, in the same manner as in the eye splice, into each other's standing part.

Fig. 101.

A WALL KNOT.

Unlay the end of a rope, and with the strand 1. (*fig.* 102.) form a bight, holding it down on the side of the rope as at 2. Pass the end of the next, 3., round the strand 1., the end of strand 4. round the strand 3., and through the bight which was made at first by strand 1., haul them rather taut, and the knot will appear as in *fig.* 103.

Fig. 102



TO CROWN THIS KNOT.

Lay one of the ends, *a*, over the top of the knot (*fig.* 104.); lay *b* over it, and *c* over *b*, and through the bight of *a*: haul them taut, and the knot with the crown will appear like *fig.* 105; which is drawn open in order to render it more clear. This is called a *Single Wall and Single Crown.*

Fig. 103.

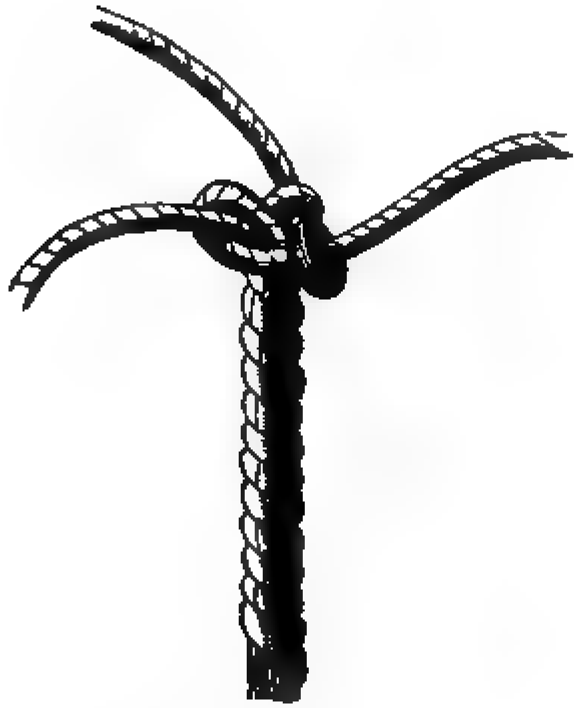


Fig. 104.

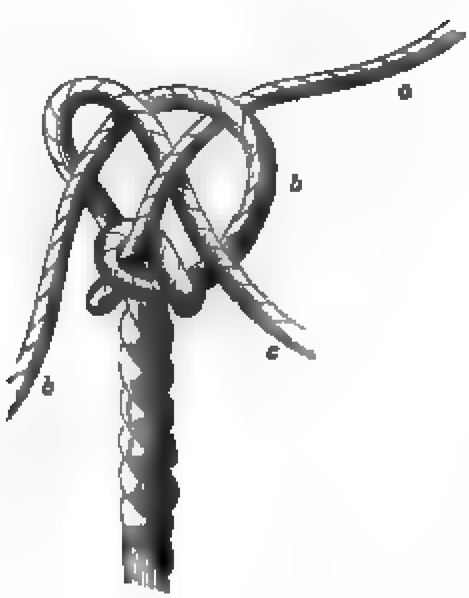


Fig. 105.

TO DOUBLE WALL THIS KNOT.

Bring the end *b* underneath the part of the first walling next *to it, and* push it up through the same bight *d* : do the same

with the other strands, pushing them up through two bights, and the knot will appear like *fig.* 106. having a Double Wall and Single Crown.

Fig. 106.

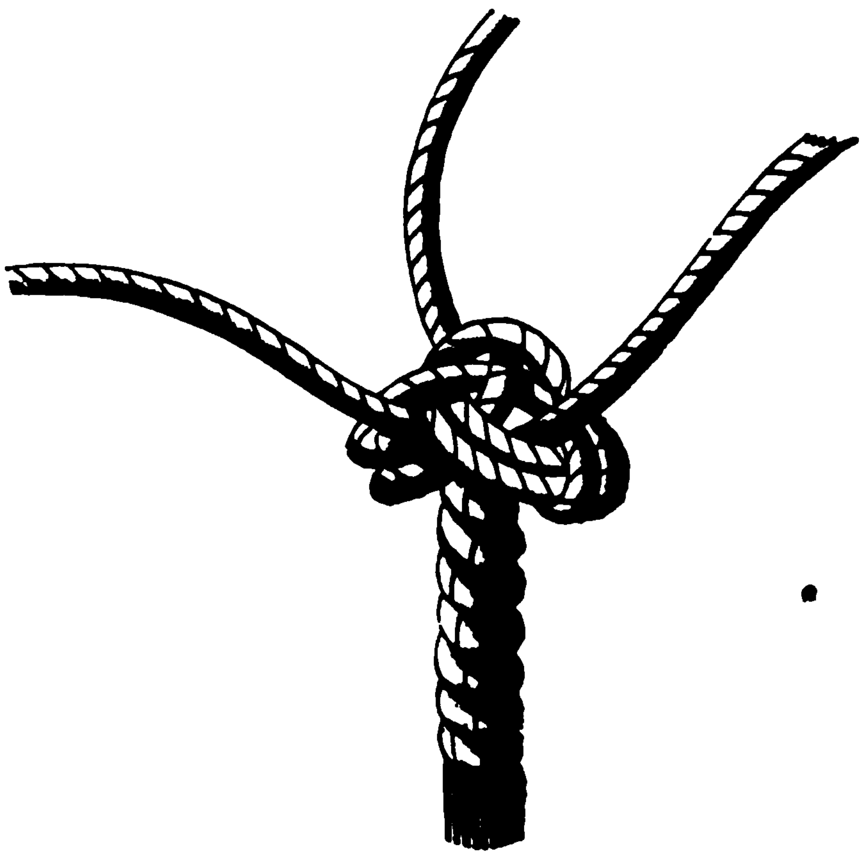


Fig. 107.

TO DOUBLE CROWN THE SAME KNOT.

Lay the strands by the sides of those in the single crown, pushing them through the same bights in the single crown, and down through the double walling. It will then be like *fig.* 107. ; viz., single walled, single crowned, double walled, and double crowned.

A STOPPER KNOT

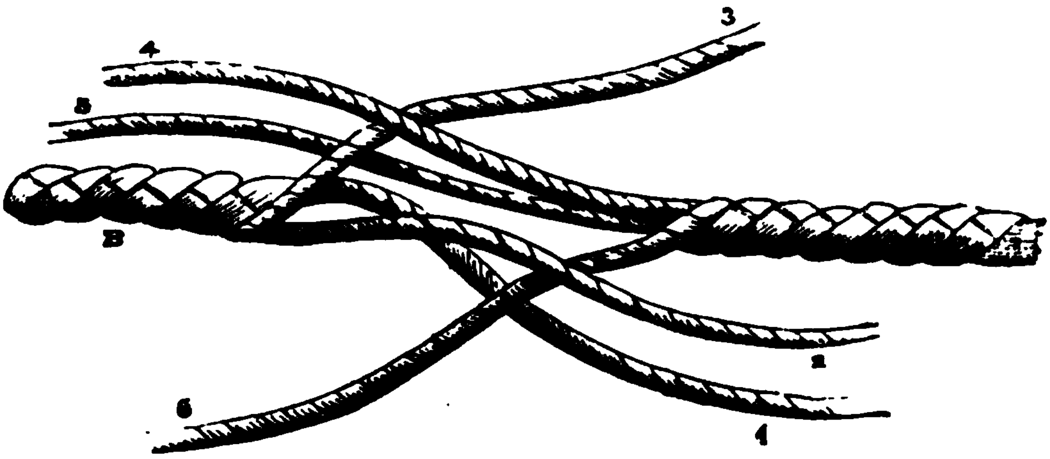
Fig. 108.

Is made by single and double walling, without crowning, a three stranded rope against the lay, and stopping the ends together as in *fig.* 108.

A SHROUD KNOT.

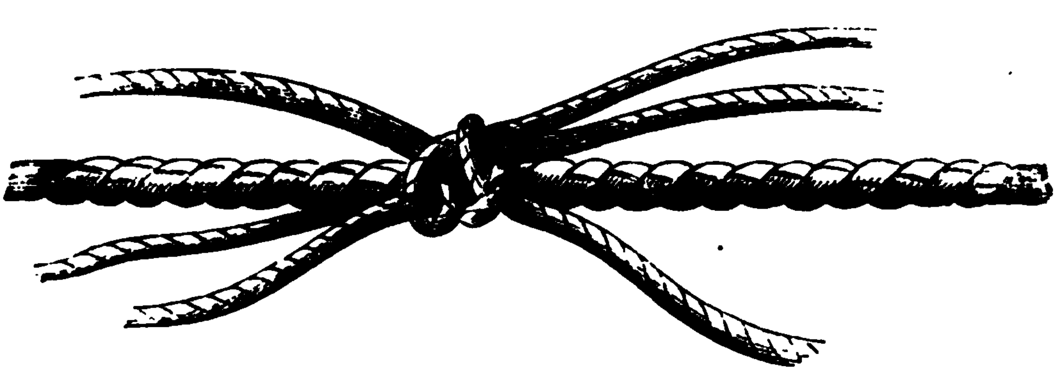
Place the strands as for splicing (*fig.* 109.), then single wall

Fig. 109.



the ends of one rope round the standing part of the other, *fig.* 110. Taper, marl, and serve the ends down.

Fig. 110.

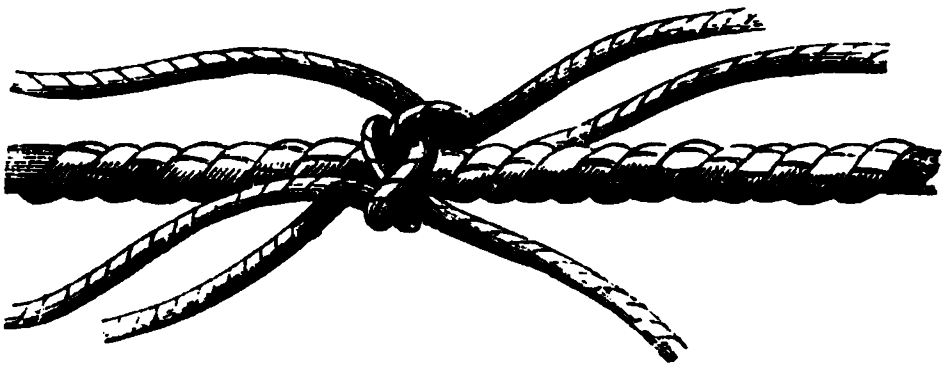


A FRENCH SHROUD KNOT.

Place the ends as in fig. 109., draw them close. Lay the ends 1, *2, 3. back on their own part,* B. Single wall the ends 4, 5, 6.

round the bights of the other three, and the standing part B, and it will appear as in *fig.* 111.

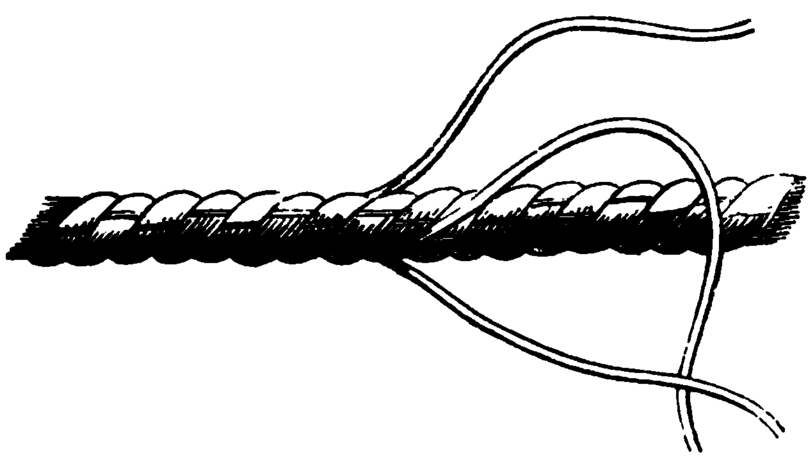
Fig. 111.



A BUOY ROPE KNOT.

Unlay the strands of a cable laid rope, and also one of the small strands out of each large one; laying the large ones up as before, and leaving the small ones out as in *fig.* 112.; then

Fig. 112.



single and double wall the small strands round the rope, worm the ends, and stop them down. *Fig.* 113.

Fig. 113.

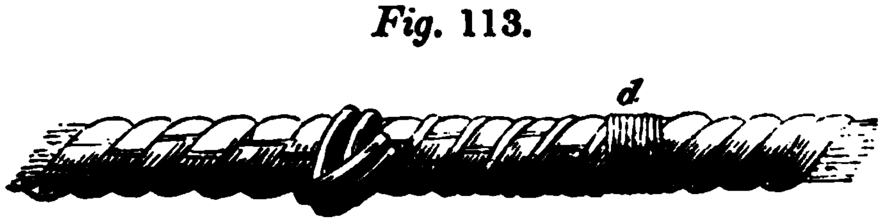


Fig. 114.

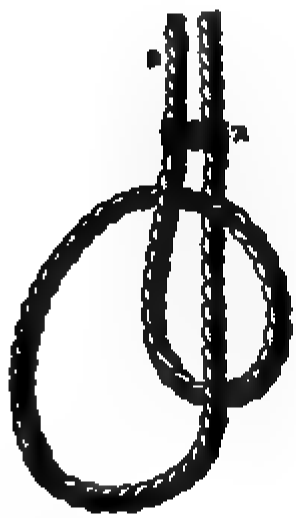


Fig. 115.

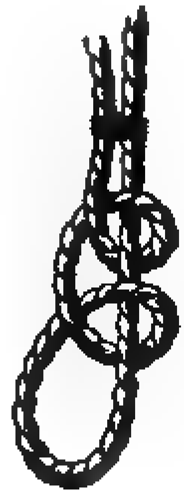
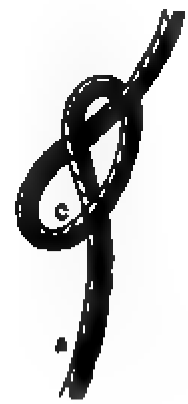


Fig. 116.



Figs. 117.

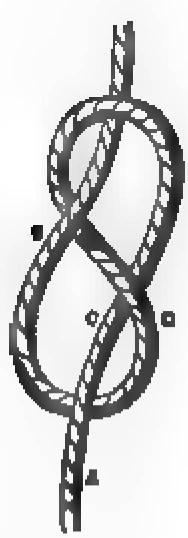


Fig. 118.

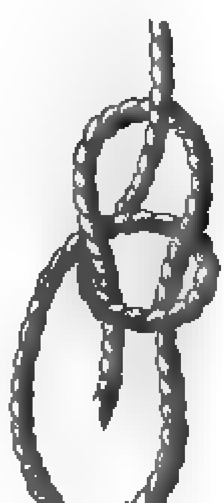
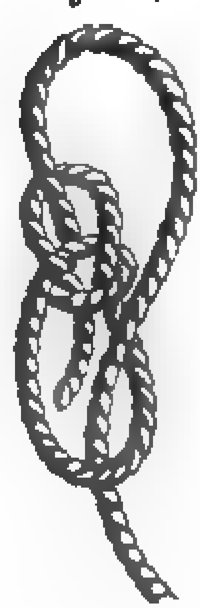
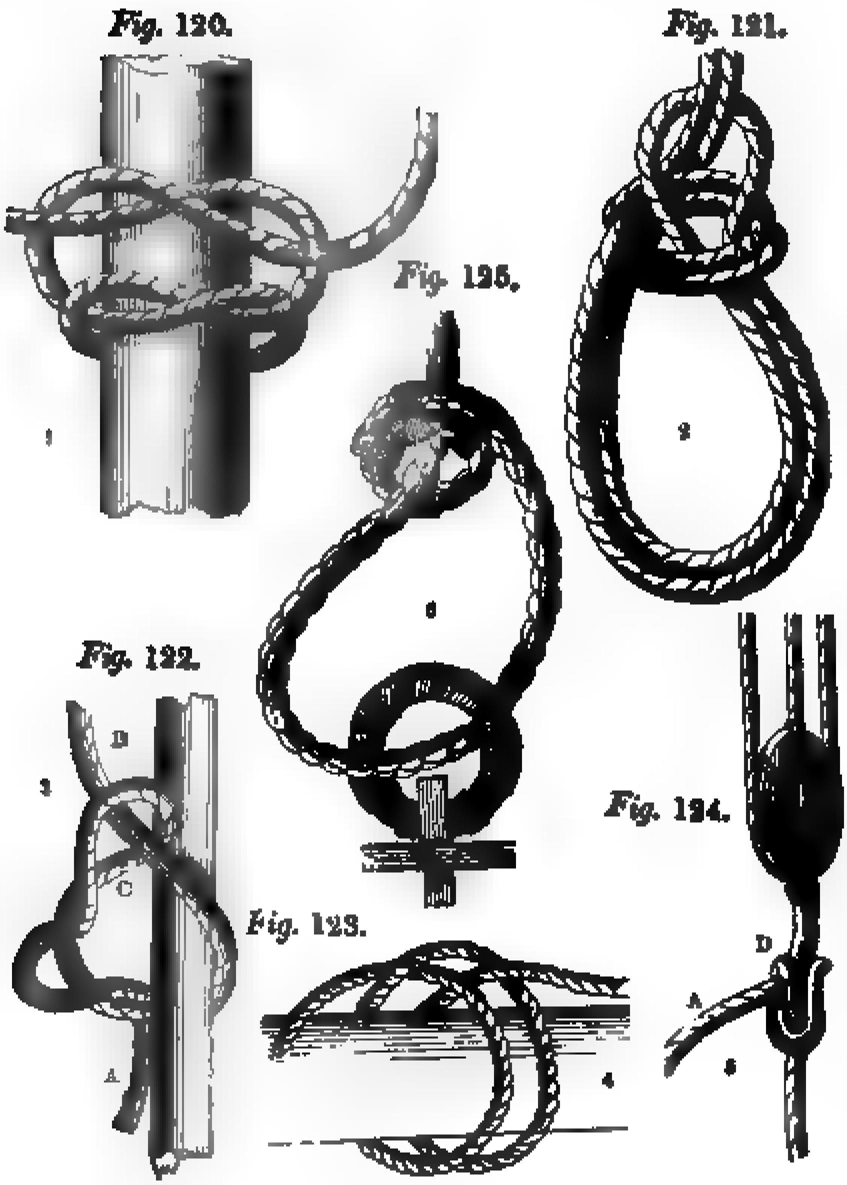


Fig. 119.



114. Half Hitch.
115. Two Half Hitches.
116. Half Hitch.

117. Overhand, or Figure-of-eight Knot.
118. Bowline Knot.
119. Running Bowline.



120. Reef Knot.
121. Bowline on a bight.
122. Timber Hitch.
123. Clove Hitch.
124. Blackwall Hitch.
125. Cable Clench.

MATTHEW WALKER'S KNOT.

Open the strands and take the end 1. *fig.* 126. round the rope and through its own bight; the end 2. underneath, through the bight of the first, and through its own bight, and the end 3. underneath, through the bights of the strands 1. and 2., and through its own bight. Haul them taut, and they form the knot *fig.* 127.

Fig. 126.

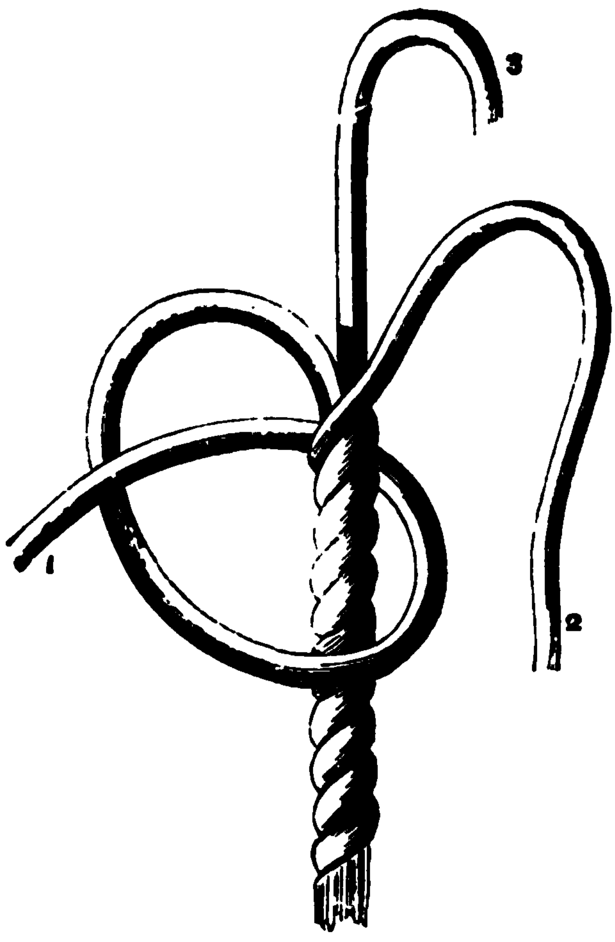


Fig. 127.

A SINGLE DIAMOND KNOT.

Unlay the end of a hawser laid rope for a considerable length, and with the strands as in *fig.* 128. form three bights down its side. Put the end of strand 1. over strand 2. and through the bight of strand 3. Then put 2. over 3. and through the bight formed by 1. and the end of 3. over 1., and through the bight of 2. Haul these taut, lay the rope up again, and the knot will appear like *fig.* 129.

Fig. 128.

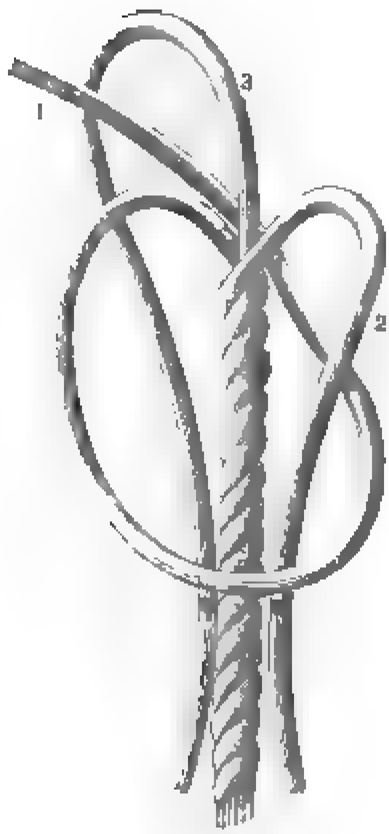


Fig. 129.

Fig. 130.

A DOUBLE DIAMOND KNOT.

With the strands opened out again, follow the lead of the single knot through two *single* bights, the ends coming out at the top of the knot, and lead the last strand through two *double* bights. Lay the rope up again as before, when it appears as in *fig.* 130.

A SPRIT SAIL SHEET KNOT.

Unlay two ends of a rope as in *fig.* 131.

Make a bight with the strand 1.; wall the six ends together against the lay of the rope in the same manner as the single walling was made with three, putting the second over the

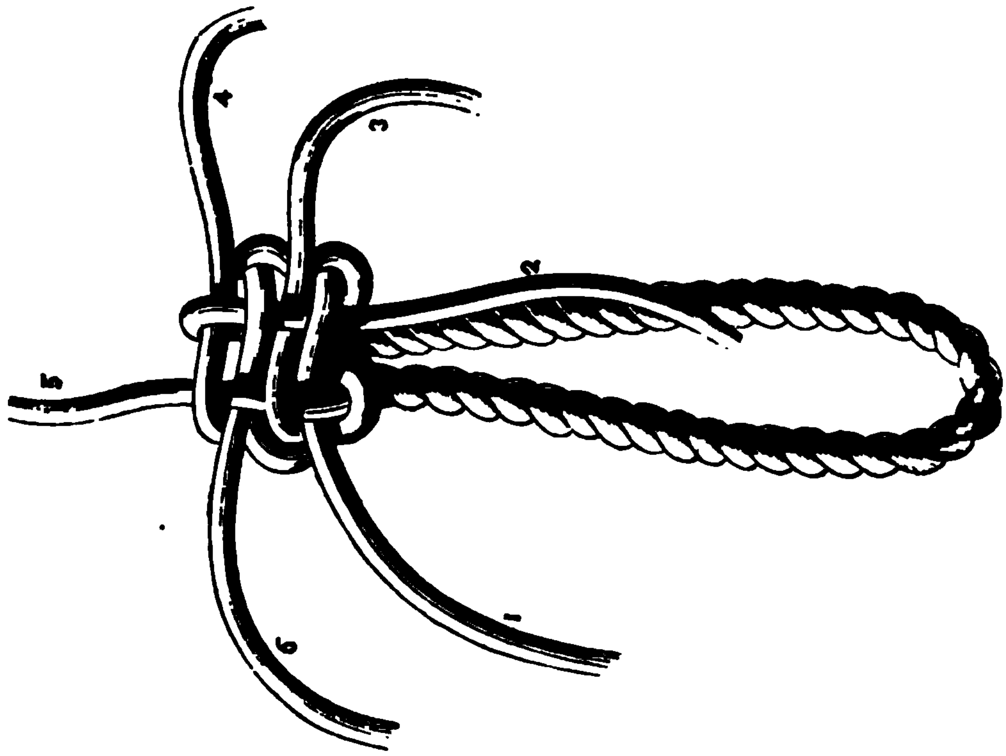


Fig. 133.

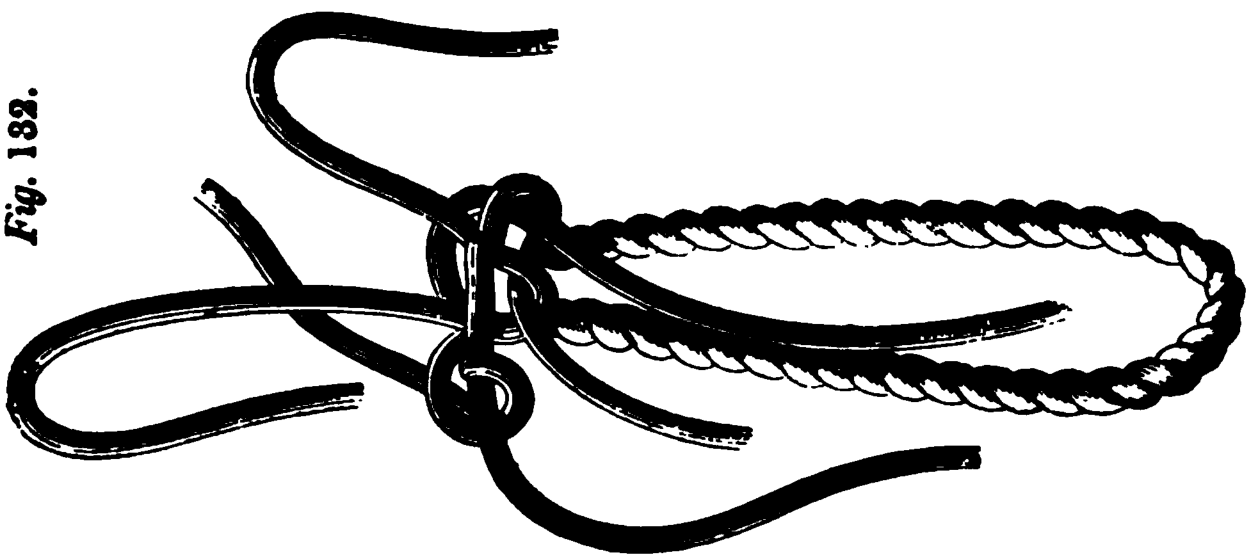


Fig. 132.

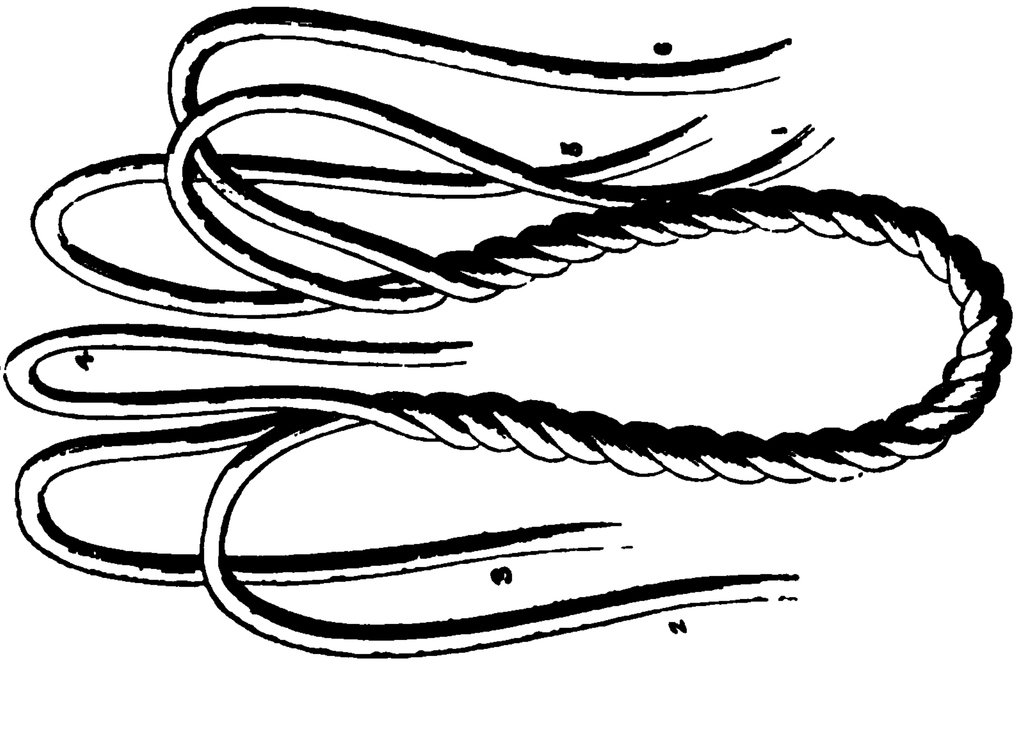


Fig. 131.

first, the third over the second, the fourth over the third, the fifth over the fourth, the sixth over the fifth and through the bight which was made by the first; haul them rather taut, and the single walling will appear like *fig.* 132.; then haul taut. To crown this, take 5 and 2 across the top of the walling, passing the other strands alternately over and under those two, when it will appear as in *fig.* 133.

A TURK'S HEAD

Is worked round a rope with a piece of long line. Make a clove hitch as in *fig.* 134., bring the bight *d* under the bight *g*, and take the end up through it; it will then appear like *fig.* 135. Make another cross with the bights, and take the end down, after which follow the lead, and it will form a knot as in *fig.* 136.

Fig. 134.

Fig. 135.

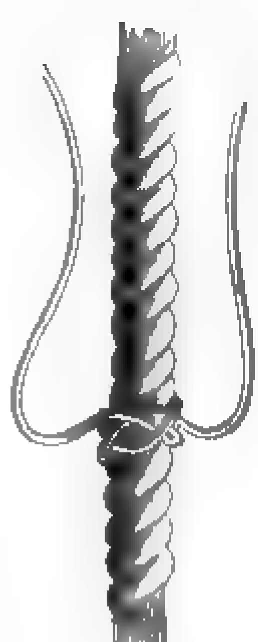
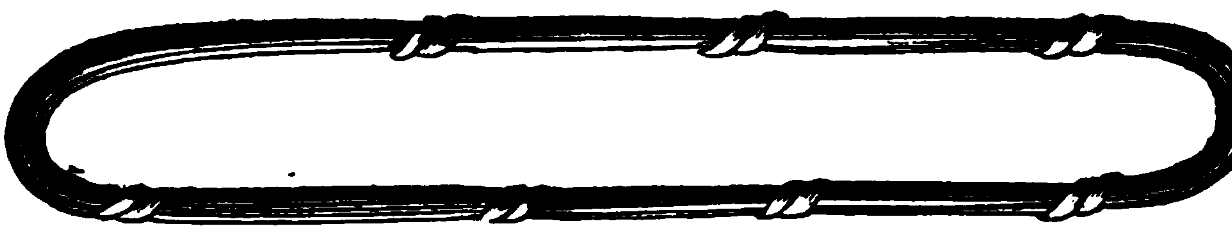


Fig. 136.

A SELVAGEE

Is made by laying rope yarns in a bight, and marling them down with spun yarn.

Fig. 137.



TO LENGTHEN A ROPE BY AN ADDITIONAL STRAND.

Cut the strand (*fig.* 138.) and unlay it as far as *b*, and there cut the strand *b*. Unlay those two strands the same length (*fig.* 139.), and cut the strand *c* at *d*. Draw the two parts of the rope asunder to the proper distance, laying the end part of the longest strand, *d*, on one side over the shortest on the other, *e*. Introduce the additional strand *e*, lay it on at *d* to *e*, and then follow up the lay with the two longest strands to *a*. The ends are knotted and pushed through, as in the long splice.

Fig. 138

Fig. 139.

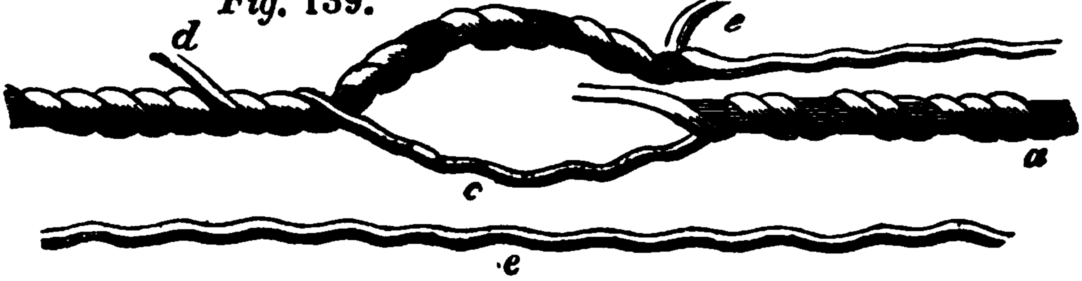


Fig. 140.

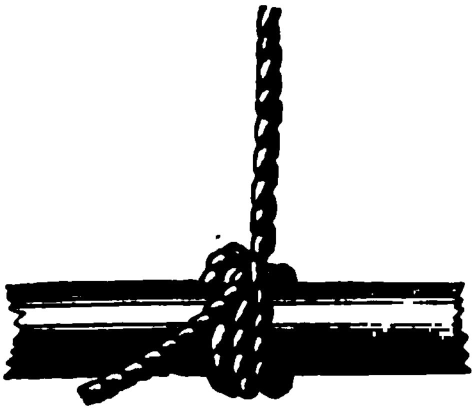


Fig. 141.

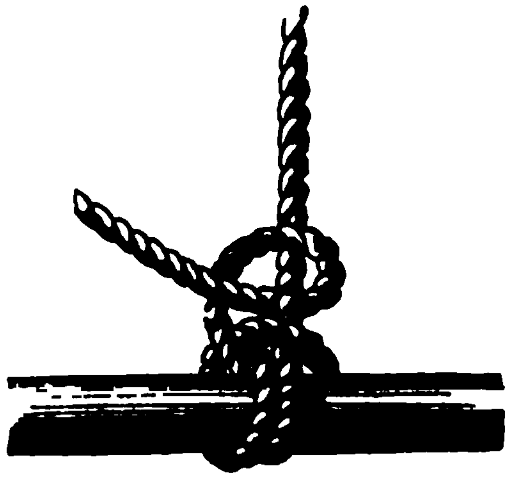


Fig. 142.

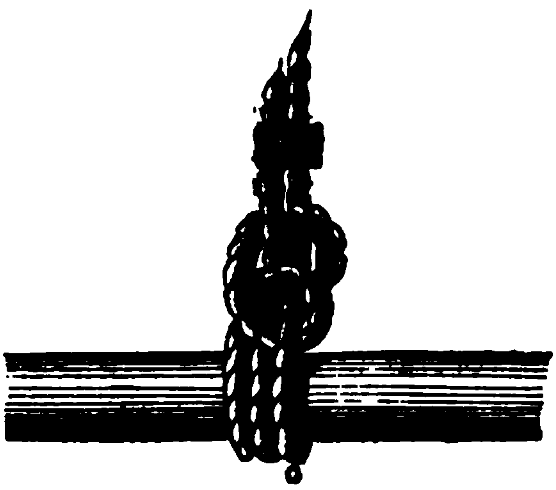


Fig. 143.

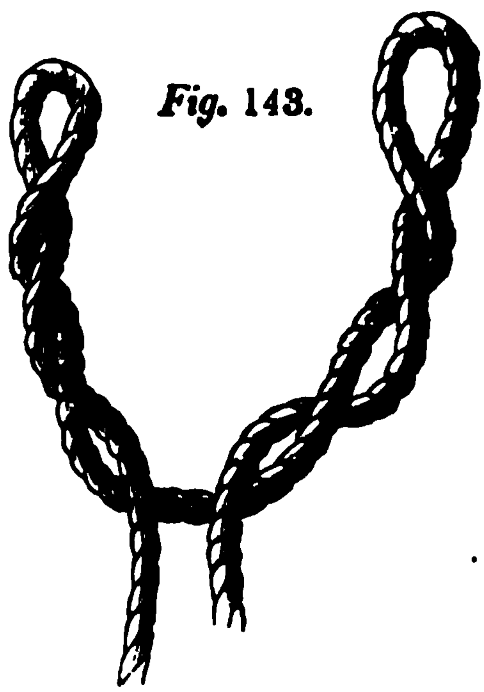


Fig. 144.

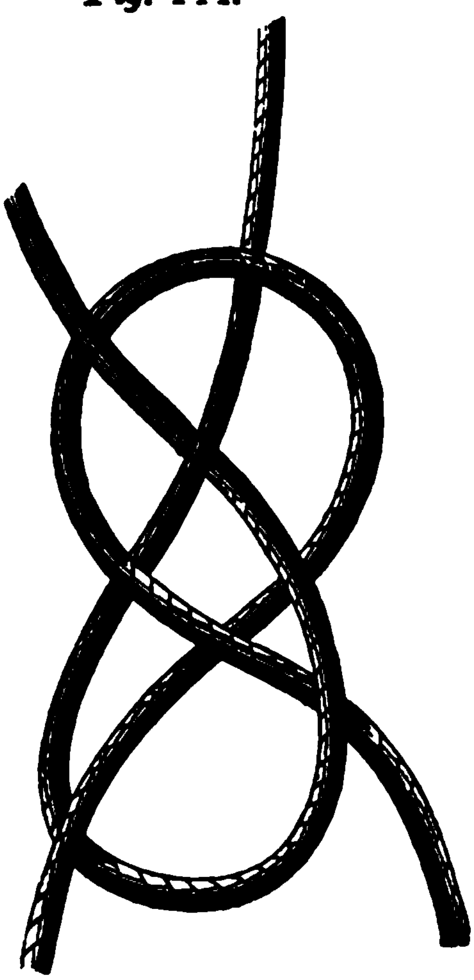
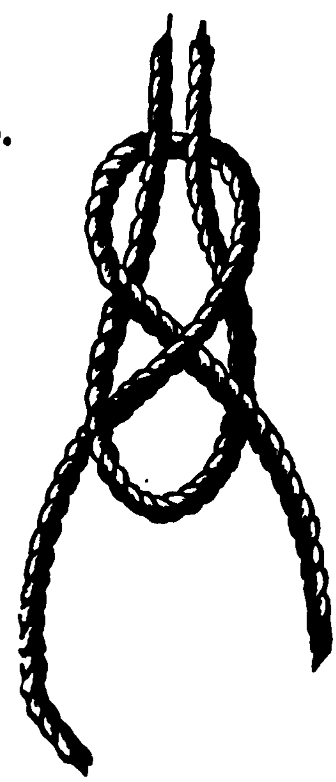


Fig. 145.



140. Magnus Hitch.
141. Fisherman's Bend.
142. Rolling Hitch.
143. Cat's paw.
144. Carrick Bend.
145. Sheet Bend.

Fig. 146.

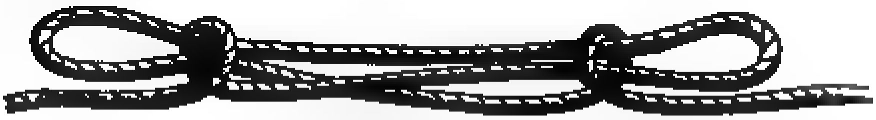


Fig. 147.

Fig. 148.

Fig. 150.

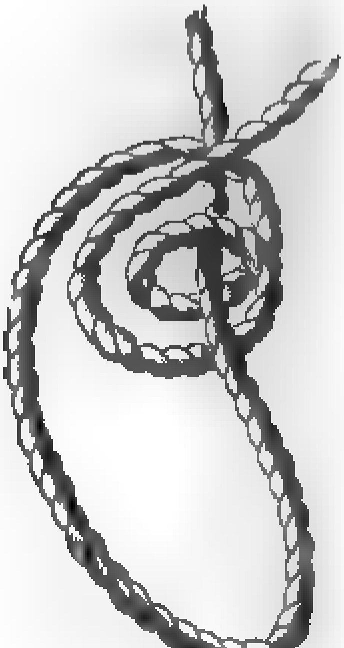
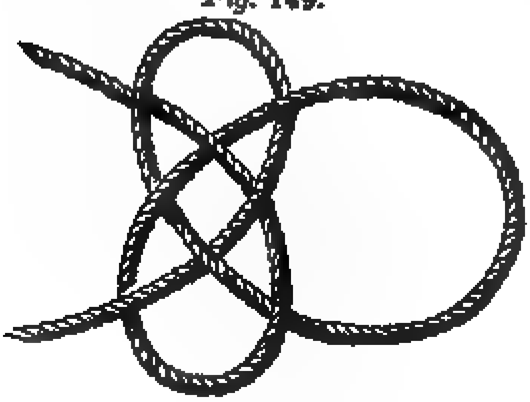


Fig. 149.



146. Sheepshank.
147. Hawser Bend.
148. Harness Hitch.
149. Prolong.
150. Midshipman's Hitch.

A GRUMMET

Is made by unlaying a strand of rope, *fig.* 151., placing one part over the other, and with the long end *f* following the lay till it forms the ring, *fig.* 152. Splice the ends in.

Fig. 151.

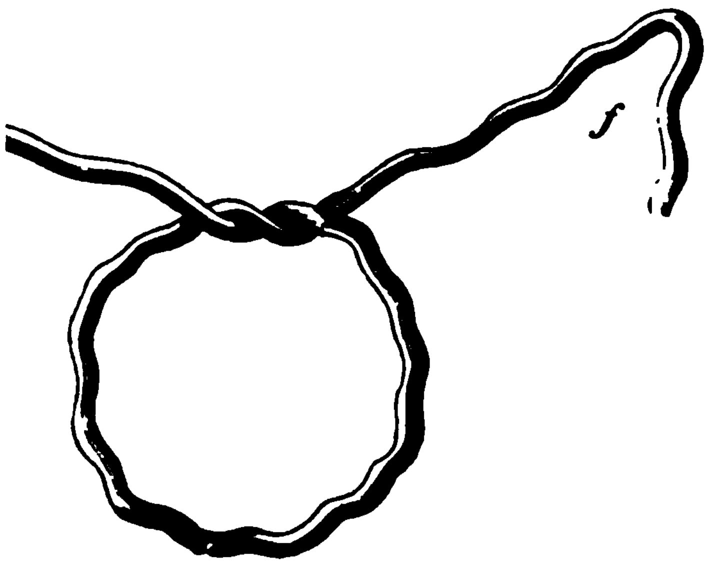


Fig. 152.

Fig. 153

A ROUND SEIZING.

Splice an eye in the end of a seizing, and place it as in *fig.* 153. Pass 6, 8, or 10 turns, according to the size of the rope, heaving them taut; then bring the end up as in *fig.* 154., and pass the riding turns hand taut. These are always one less than the first. Push the end up through the seizing, and heave on two cross turns, securing the end as in *fig.* 155.

Fig. 154.

Fig. 155.

Fig. 156.

Fig. 157.

A THROAT SEIZING

Is passed with riding turns, but not crossed. A bight is formed by placing the end A over the standing part B in *fig.* 156. The seizing is then hove on. The end A is brought up and seized to the standing part, as in *fig.* 157.

These cuts are taken from Lever's Sheet Anchor.

CHAP. XIII.

ANCHORS AND CABLES.

The Admiralty anchors are formed piecemeal: the shank arms and palms are wrought out of iron bars, hammered together into solid masses called "Blooms," and then scarphed together. Stocks are in length equal to the whole length of the shank. When of iron, they are 20 per cent. the weight of the anchors, and reeve through a hole in the shank, a curve at one end, and a shoulder and pin in the centre, preventing them from being easily disengaged, but also admitting of their being laid along the shank for convenience in stowage.*

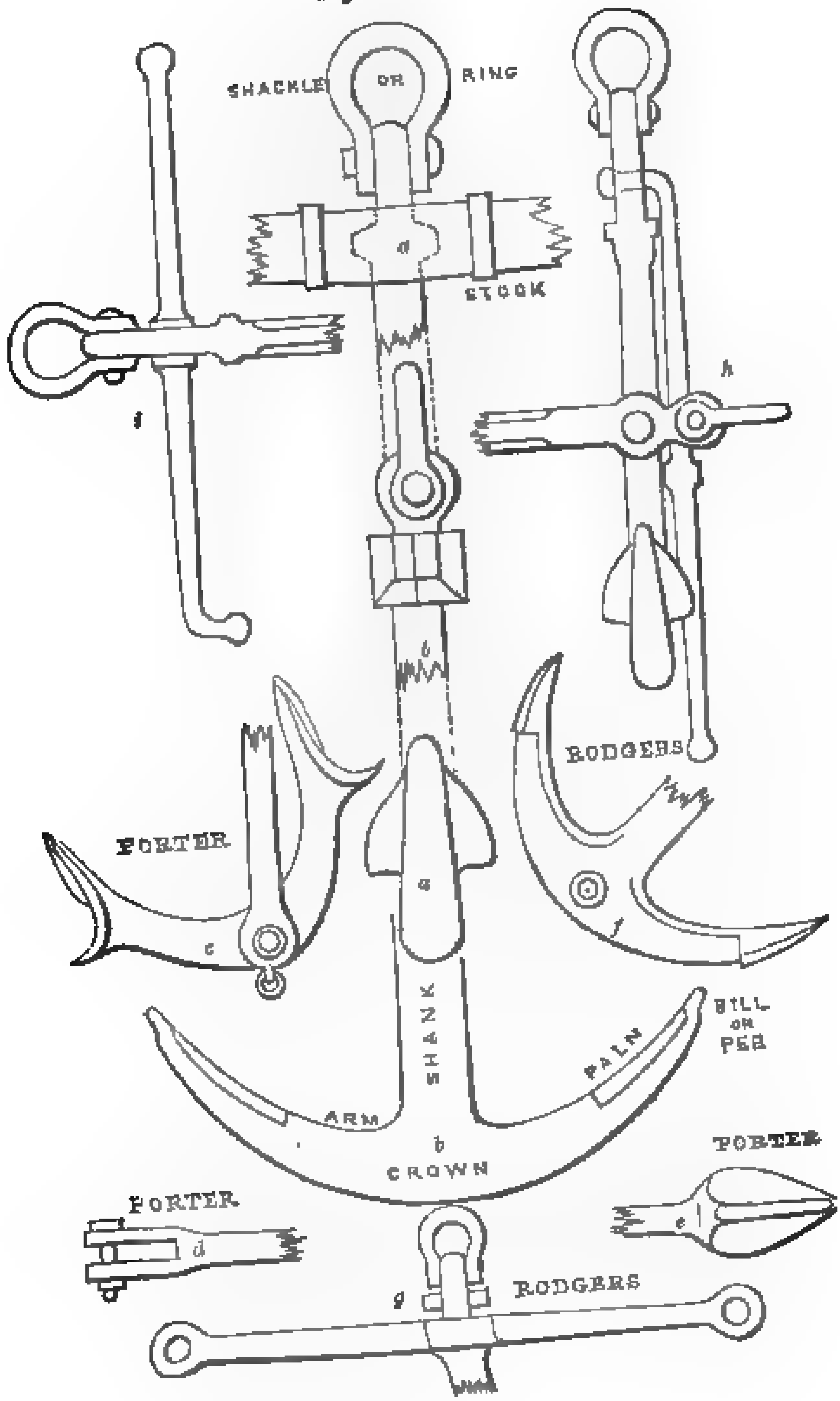
Wooden stocks are of oak in two pieces, left sufficiently apart in the middle to give greater binding power to the hoops, and to admit of their being driven up when the wood shrinks. In breadth and depth, they are at the middle $\frac{1}{12}$th, and at the ends $\frac{1}{24}$th of their length.

Porter's anchors are made with the intention of being more portable: the shank is connected with the arms at the crown by a bolt. The palm is small, and made with a horn on the back, which is meant to assist in opening the lower arm when it takes the ground. They are troublesome to fish, and difficult to sweep; but they are readily taken to pieces, do not require very large boats to carry them out, and are put together without delay. When on the ground, the upper arm is shut close down on the shank; and if the anchor has been properly let go, a ship may ride with a long scope of cable all round the compass for a whole season of variable winds without fouling. It does not "bite" readily on soft ground, and, therefore, is not a favourite for harbour work where it is necessary to bring up short. It should be let go with little more cable than will reach the bottom, and then "snubbed" hard to make it open.

Rodgers' anchors are made with a small palm, and frequently

* On next page will be found sketches of different anchors (*fig.* 158.). Thus, *a*, *b*. The Admiralty wooden-stocked anchor. *c*. The arms of Porter's anchor. *d*. The crown end shank of Porter's anchor. *e*. The palm of ditto. *f*. The arms of *Rodgers'* anchor. *g*. The iron stock of ditto. *h*, *i*. The *Admiralty iron stocked* anchor.

Fig. 158.


SHACKLE OR RING
a
STOCK
i
h
b
RODGERS
PORTER
a
c
f
BILL OR PEE
SHANK
PALM
ARM
b
CROWN
PORTER
PORTER
d
e
g
RODGERS

with an iron stock, which ships on, over the head of the shank, and under the shackle. It bites readily. It cannot, however, be unstocked without unshackling the cable, and is not so easily swept as the broad-palmed ones are.

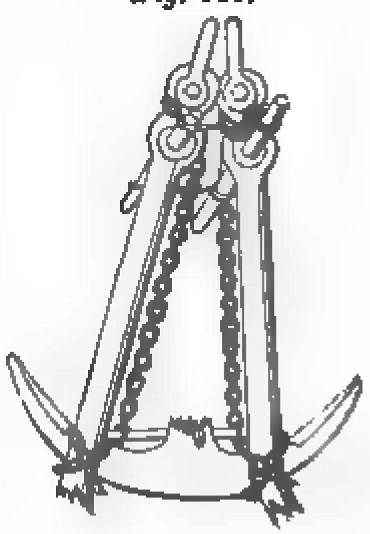
Fancy has been at work among the "mud hooks," and produced other kinds of anchors not worth our consideration. Those supplied to the navy are of the most approved form, and have undergone the requisite ordeal as to strength; but the truth is, that no one kind of anchor can have its superior merit endorsed by a committee however sagacious, and a bad sailor will be like the bad reaper; for the best anchor will fail if it be let go without care, or remain on the bottom without attention.

The hoops of wooden-stocked anchors should be hardened up after very hot weather. Two sheet anchors were let go by a line of battle ship during a winter gale at Vourla, and the stocks were knocked off by striking the side in letting go. The hoops were slack, and proper care had not been taken to arrange the tripping strop.

JURY ANCHORS.

A jury anchor has been formed with broken shanks and flukes thus:—"The two shanks were carried close out to the palms of the anchor, on opposite sides, and then lashed with top-sail sheet chains. The two stocks were secured together with chains of the same description. An iron bar was lashed across the shanks, securing in the centre the remaining piece of the shank. A length of stream chain was then passed through the rings, down along the shanks, with a round turn round each palm and shank, then back and secured. By this means, when strain comes on the arms, it is thrown on the chain by the shanks being inclined to draw through the small lashings; while in so doing, the stream chain acts as a vice, and the more the shank draws, the firmer is the arm grasped by the round turn of the stream cable, whilst the stream

Fig. 159.



Milnes' Jury Anchor.

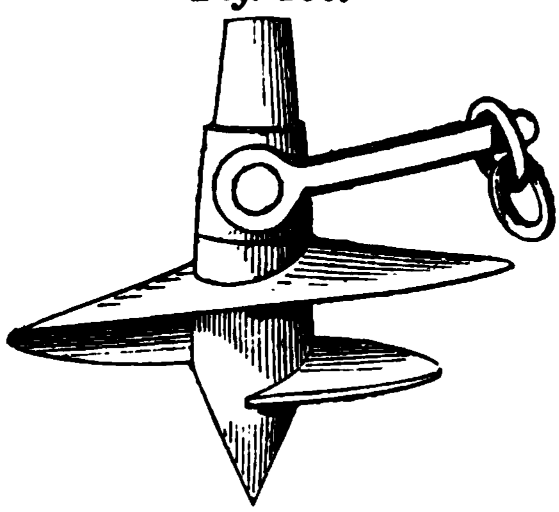
cable prevents the shanks from drawing out altogether. This anchor was found quite efficient." *

A whaler that had parted, brought up, and rode out a heavy gale in Table Bay, by slinging and letting go a boiler with a cable made fast to the spans.

Guns are a resource, when without anchors. Haul the cable from the hawse hole along the side, by a warp from aft, keeping it up with slip ropes from the ports, and lash it to a certain number of guns round their chase ; pass the ends of the breechings round the cable, and secure them on top of the gun : heave all over board together. In weighing them, hoist them with the cat, as they reach the hawse hole, and take them in through the bow-port.

There are also very powerful screws made use of for mooring purposes which, having a broad flange nearly four feet in diameter, present a resistance, when entered into the ground, equal to that of ten square feet. This is not only much greater than that of an anchor, but is less liable to be fouled by other ground tackle.

Fig. 160.



Mitchel's Screw Anchor.

The chain is connected with a revolving collar. The screwing down is effected by a key, which is placed piece by piece as the screw is lowered; the collar admitting of the turning, without fouling the cable. When the screw has been sunk to the desired depth, the key is removed.

The foundation for the lighthouse on the Maplin Sands was formed on pilings shod with these screws.

CHAIN CABLES.

All the Chain gear pertaining to ships, excepting the rudder

* *Captain Milnes'* Report on a jury anchor rigged on board H. M. S. "*Snake*."

chains, is made of wrought iron. The size is denoted by the diameter of the bars of which the links are composed.

Chain cables are 8 lengths of 12½ fathoms each.

Admiralty Specification of Chain Cable.

"The iron chain cables are to be made in 12½ fathom lengths, with one swivel in the middle of every other length, and one joining shackle to each length, and of the weight specified.

"The several sizes of chain cables being distinguished by the diameter of the iron of their common links, this diameter forms the unit of the scale of dimensions in the accompanying drawings, by which the dimensions of the various parts of the cables of all sizes, and of the articles to be connected therewith, are to be proportioned. Thus, the length of a common link is to be 6 diameters, and its breadth 3·6 diameters of its iron: and the length of an end link is to be 6·5 diameters, its breadth 4 diameters, and the substance of its iron 1·2 diameters of the iron of a common link; and so on for all the parts of cables of all sizes, and articles to be connected therewith, which are to be made as near as practicable to the dimensions shown by the drawings.

"The diameter or transverse section of the iron of the links, and of the various parts of the swivels, shackles, and other articles to be connected with the cables, is not to be less, taking the mean of the greatest and least dimension at any one section, than that specified herein, or shown by the drawings. Also the length of the various links, swivels, shackles, and other articles is not to be more than $\frac{1}{10}$ of the diameter of the iron of the common links over, nor their width more than $\frac{1}{10}$ such diameter over or under that specified or indicated as above-mentioned.

"The stay pins are to be of cast iron, not exceeding the weights specified, and are not to be wider at their ends than the diameter of the iron of the links in which they are inserted, nor at their middle part than $\frac{6}{10}$ of such diameter, meaning longitudinally, of the links.

"Both the end links of every length of a cable, as well as those of Sir Thomas Hardy's mooring swivels, splicing tails, and *splicing shackles*, are to be made parallel-sided without stay-

pins, and with the substance of their iron $\frac{3}{10}$ of a diameter larger than the diameter of the iron of the common links of the cable to which they belong, as shown by the drawings, and so as to admit the joining shackles to be inserted or taken out of them in connecting or disconnecting any two lengths of the same, or of different cables, of the same size, by either end ; also to receive the bolt of the large shackle for connecting any length of cable of the same size by either end with the anchor.

"The enlarged links connected with the end links, and with each end of the swivels, are to be made $\frac{1}{10}$ part larger in the diameter of their iron than the common links of the cable they belong to, and with a stay-pin in proportion.

"The splicing tails of the different sizes, for connecting iron and hempen cables together, are each to consist of one end link, without a stay-pin, followed by one enlarged link, fourteen common links, and then another enlarged link, all with stay-pins, and all the before mentioned links are to be of the same size as those of the iron cable, to which the splicing tail is to be attached ; also of a triangular link, no wider nor longer than necessary, of iron 1·3 diameter of that of the common links, connected at its narrow end with the last-mentioned enlarged link, and at its broad end with three short-linked chains (without stay-pins) called tails, the first link of each of which, connected with the triangular link, is to be of iron $\frac{8}{10}$ diameter of that of the common links, and the remaining links of each tail, about sixty-five in number, are to diminish gradually in size to iron of $\frac{1}{4}$ of the diameter of that of the common links before mentioned.

"The steel tinned pins for retaining the joining shackle bolts, and the forelocks for the large shackle-bolts, are not to follow the exact proportion agreeably to the diameter of the iron of the common link, laid down for other parts of cables.

"The length of the steel pins to be such, that the points do not come through the shackles by the diameters of their points. All the steel pins are to be filled with dovetail chambers, to receive the leaden pellets at their heads.

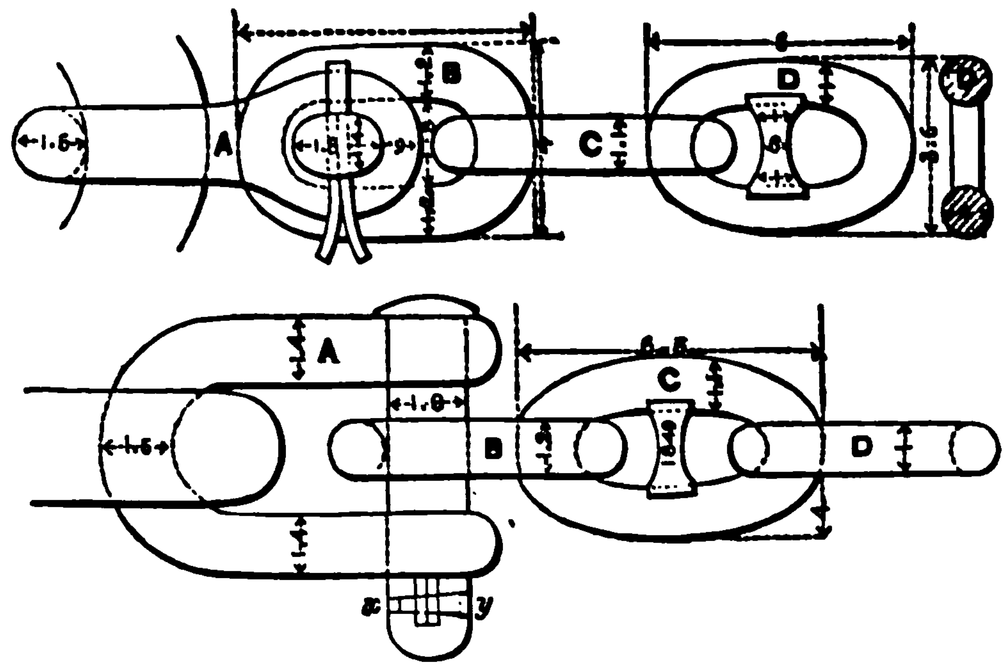
"In order to prevent the forelock in the bolt of the large shackle being accidentally displaced, a steel pin in the lead pellet is to be introduced through the bolt and the forelock. The split in the forelock is to be retained.

"The iron square linked mooring chains are to be made in 10-fathom lengths, and the length of each link is to be 3 feet, so that each chain will consist of 20 links."

"*Drawings hereinbefore referred to.*

"Showing the proportions of iron chain cables, mooring chains, and other articles connected therewith, to be supplied for Her Majesty's Navy.

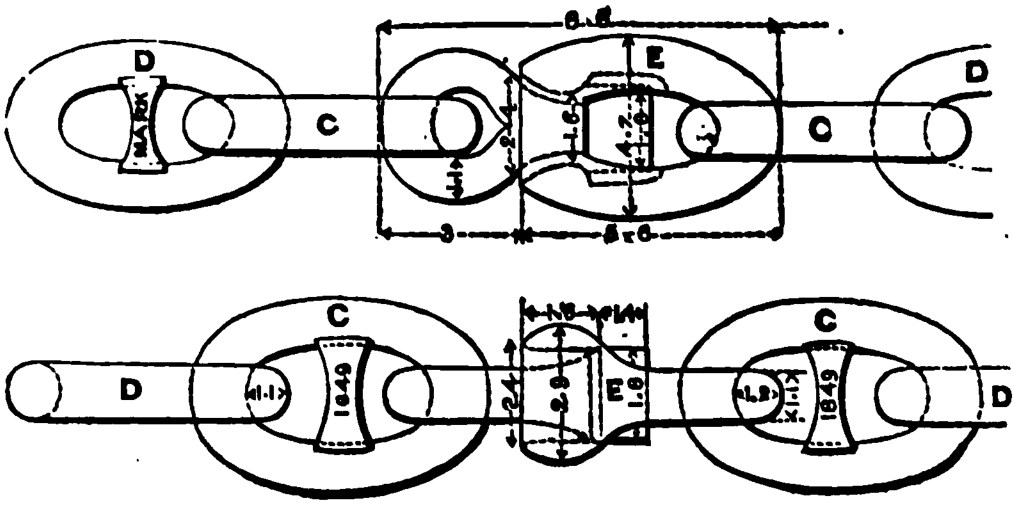
Fig. 161.



Anchor Shackles.

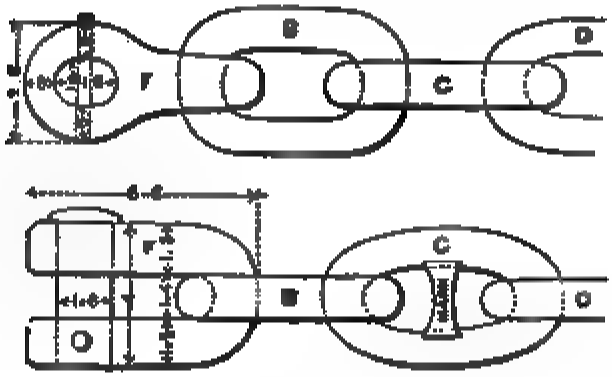
x y. Pin and lead pellet through the bolt and forelock.

Fig. 162.



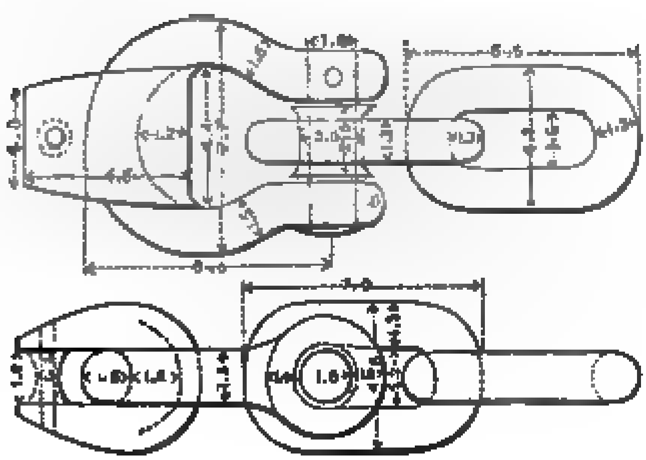
Cable Swivels.

Fig. 163.



Cable Shackle.

Fig. 164.



Splicing Shackle, on Admiral the Hon. George Elliot's Plan.

REFERENCES.

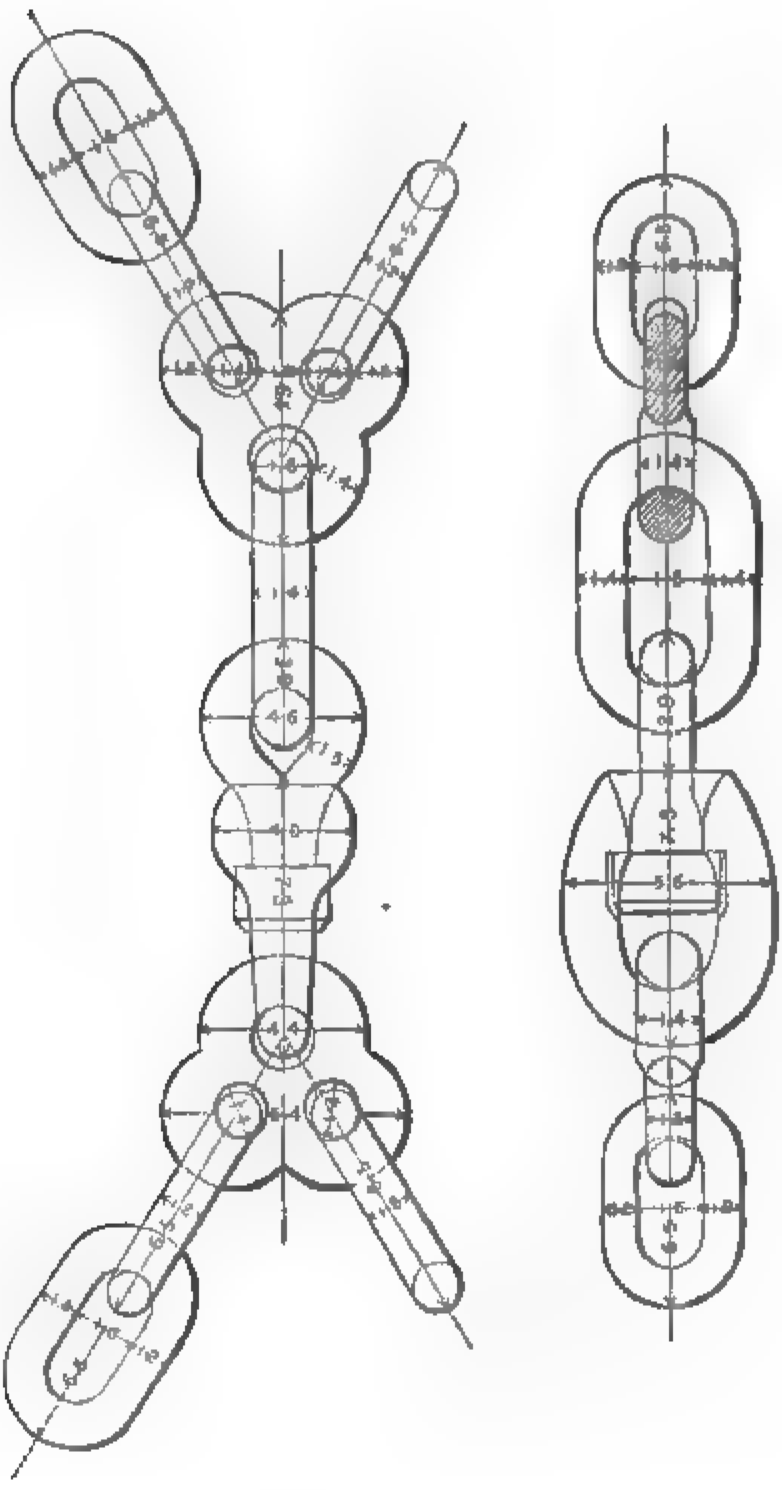
Two Views of the various parts of a Cable are here shown.

A. Large shackle for connecting any length of cable of 12½ fathoms with the anchor.
B. End links, without stay pins.
C. Enlarged links, with stay pins.
D. Common links.
E. Swivel in the middle of every other length.
F. Joining shackle for connecting either end of any length with any other length of the same size.

The written dimensions on the links, &c., signify so many diameters of the *iron of the* common links of the cable, thus forming the scale for all sizes. *In the* mooring chains and gear, the unit is the thickness of the iron of the link.

Fig. 165.

Mooring Swivel, on Sir Thomas Hardy's Plan.

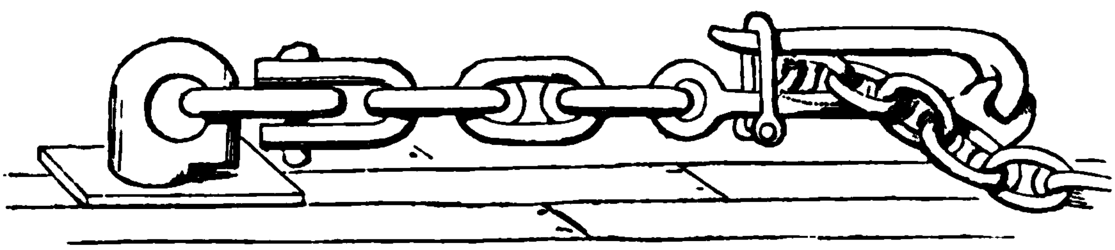


Messenger chain is made in open oblong links, which are alternately long and short. It is connected by a peculiar *splicing piece.*

Crane chain is made in open oval links. Having no stay, its strength as compared to stayed chain is as 7 to 9 : but being more flexible, it is used for rigging and machinery purposes.

The *Clear Hawse Shackle* is made long enough to clasp a cable link, and admit of a hawser being rove through its bight. It is nearly obsolete, and a *Slip Stopper*, such as is used for stoppering the cable, *fig.* 166., and tricing it up in the chain locks, is made use of for clearing hawse purposes instead. The

Fig. 166.



advantage of the stopper in clearing hawse is, that it is easier applied and taken off; besides, a length of chain may be shackled on to it, and a wet hawser avoided.

Top chains are generally crane, and *Mast-head slings* of cable pattern. A first rate's slip stopper for the cable is about 8 cwt.; a sloop's about 1 cwt. A first rate's mast-head and yard sling about 32 cwt.; a sloop's about 6 cwt.

" The proof strain of chain cables is about 630 lbs. in each circular inch of the iron bolts of which it is made. Thus, a cable made of one inch iron, contains on one side of the link $8 \times 8 = 64$ circular eighths; which, being multiplied by 630 lbs., gives 40,320 lbs., or 18 tons." *

* Rudimentary Art of constructing Cranes, &c.

Table of the Number and Weights of Anchors, and Number and Size of Cables and Messengers supplied.

	1st Rate.		2nd Rate.		3rd Rate.		4th Rate.		5th Rate.		6th Rate.		Corvettes. 1st Class Brigs.		2nd Class Brigs.		Brigantine.	
	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.
		cwt.		cwt.		cwt.		cwt.		cwt.		cwt.		cwt.		cwt.		cwt.
ANCHORS— Bower -	4	99	4	85 to 94	4	73 to 81	4	61 to 70	4	44 to 57	4	27 to 41	4	23 to 25	4	21	3	11 to 15
Stream -	1	25	1	21 — 23	1	18 — 20	1	15 — 18	1	12 — 14	1	8 — 12	1	7	1	6	1	5
Kedge {	1	12	1	10 — 12	1	9 — 10	1	8 — 9	1	6 — 7	1	4 — 6	1	4	1	3	1	3
	1	7	1	6 — 7	1	5 — 6	1	4 — 5	1	4	1	2 — 4	1	2	1	1½		
	No.	Size.	No.	Size.	No.	Size.	No.	Size.	No.	Size.	No.	Size.	No.	Size.	No.	Size.	No.	Size.
		inches.		inches.		inches.		inches.		inches.		inches.		inches.		inches.		inches.
HEMP CABLES— Bower -	2	26	2	23½ to 24	2	22 to 23	2	20½ to 22	2	18½ to 20	2	14 — 18	1	14	1	13	1	12
Stream -	1	15	1	15	1	14	1	13	1	12½	1	9 — 12	1	9	1	8	1	7
Messenger	2	15	2	15	2	14	2	13	2	12	2	10 — 11	2	10	2	8	2	7
CHAIN CABLES— Bower -	4	2¼	4	2¼	4	2⅛	4	2	4	1¾ to 1⅞	4	1⅜ — 1⅝	3	1⅜	3	0¾	3	0⅝
Stream -	1	1⅝	1	1⅝	1	1½	1	1½	1	1⅜	1	0⅞ — 1⅜	1	0⅞	1	0⅝	1	0⅝
Messenger	1	$1\frac{9}{16}$	1	$1\frac{9}{16}$	1	1⅜	1	1⅝	1	1¼	1	1⅜	1	1	1	1	1	0⅞

Splicing Shackles, Mooring Swivels and Chains.

Weight and Value of Splicing Shackles for Cables of

inch.	cwt.	qrs.	lbs.	
2¼	4	1	24	Cables, 1 inch and upwards £2 5 7 } cwt.
2⅛	3	3	14	Under 1 inch £2 15 9 } cwt.
2	2	3	0	
1⅞	2	0	0	
1¾	1	2	22	
1⅝	1	2	0	
1½	1	2	22	
1⅜	0	3	20	
1¼	0	2	24	
1⅛	0	2	4	
1	0	1	0	
⅞	0	1	1	
¾	0	0	23	

Weight and Value of Mooring Swivels.

inch.	cwt.	qrs.	lbs.	
2¼	9	3	14	Cables, 1 inch and upwards £1 12 10 } cwt.
2⅛	7	2	14	Under 1 inch 3 10 4 } cwt.
2	6	0	0	
1⅞	5	0	0	
1¾	3	2	21	
1⅝	2	3	0	
1½	2	1	21	
1⅜	2	0	10	
1¼	1	1	21	
1	0	3	8	
1⅛	1	0	14	

Weight and Value of Mooring Chains.

Size of Link.	Weight of Link.	Weight of 10 Fms.	Test.	
	cwt.	cwt.	tons.	
3¼	3	60	108	About £1 3 0 per cwt.
3⅛	2¾	55	99	
3	2½	50	90	
2⅞	2¼	45	81	
2¾	2	40	72	
2⅝	1¾	35	63	
2½	1½	30	54	
1¾	1¼	25	40	
1⅝	1	20	30	

	£	s.	d.	
Large shackles for cables of one inch and upwards - - - -	2	1	11	per cwt.
Large shackles for cables under one inch	2	5	7	„
Joining shackles for cables of one inch and upwards - - -	1	15	4	„
Joining shackles for cables under one inch - - - -	3	6	1	„
Swivels for cables of one inch and upwards - - - -	3	3	7	„
Swivels for cables under one inch -	6	5	0	„

To find the weight of open linked chains.

The square of the diameter of the link, measured in eighths of inches, will give the weight per fathom in pounds.

Stayed chain will be about one-twelfth more.

To find the weight that may be lifted by chain.

Divide the square of the diameter of the links, taken in eighths of an inch, by eight; the quotient will give the number of tons.

The working load of chains should not exceed one third of the proof strain.

Chain Cables and Anchors.

Proof Strain.	Size Chain.	Value per cwt.			Weight per 100 fathoms.	Weight of corresponding anchors.	Proof of Anchors.
tons.	inches.	£	s.	d.	cwt.	cwt.	tons.
$91\frac{1}{8}$	$2\frac{1}{4}$	0	15	4	243	100 to 88	67 to 62
$81\frac{1}{4}$	$2\frac{1}{8}$		„		216	87 to 75	61 to 56
72	2		„		192	74 to 63	56 to 50
$63\frac{1}{4}$	$1\frac{7}{8}$		„		168	62 to 52	49 to 43
$55\frac{1}{8}$	$1\frac{3}{4}$		„		147	51 to 42	43 to 37
$47\frac{1}{2}$	$1\frac{5}{8}$		„		126	41 to 35	37 to 32
$40\frac{1}{2}$	$1\frac{1}{2}$		„		108	34 to 28	31 to 27
34	$1\frac{3}{8}$		„		90	27 to 22	27 to 22
$28\frac{1}{2}$	$1\frac{1}{4}$	0	16	0	75	21 to 16	21 to 17
$22\frac{3}{4}$	$1\frac{1}{8}$		„		60	15 to 12	16 to 13
18	1	0	16	4	48	11 to 9	12 to 11
$13\frac{3}{4}$	$\frac{7}{8}$	0	16	9	36	8 to 6	10 to 8
10	$\frac{3}{4}$	0	17	10	27	$5\frac{1}{2}$ to 5	7 to 6
$8\frac{1}{2}$	$\frac{11}{16}$	0	18	7	22	4 to 3	6 to 5
7	$\frac{5}{8}$	1	0	1	18	$2\frac{1}{2}$ to 2	4
$5\frac{1}{2}$	$\frac{9}{16}$	1	2	3	15		
$4\frac{1}{2}$	$\frac{1}{2}$	1	2	7	12	$1\frac{1}{2}$ to 1	3
$3\frac{1}{2}$	$\frac{7}{16}$	1	4	0	9		

Four pounds to the ton is about the scale by which anchors are supplied to ships.

Dimensions of Lockers for 200-fathom Chain Cable.

Size.	Cubic feet.	Size.	Cubic feet.	Size.	Cubic feet.
$2\frac{1}{2}$	355	$1\frac{5}{8}$	180	1	73
$2\frac{1}{8}$	331	$1\frac{1}{2}$	156	$\frac{7}{8}$	56
2	288	$1\frac{3}{8}$	131	$\frac{3}{4}$	46
$1\frac{7}{8}$	245	$1\frac{1}{4}$	115	$\frac{11}{16}$	33
$1\frac{3}{4}$	*220*	$1\frac{1}{8}$	99		

Chain cables are meant to be worked with the curves of all the shackles forward, so as to render readily round the bitts and through the passages on being veered. This is a necessary condition, and must be remembered not only when handling the cables, but also during surveys, when many transpositions take place. "Knuckles aft," or, in other words, curves forward is the rule.

Before putting the cables in the lighter, mark them with a piece of *iron* wire at every length, commencing from the anchor end. Copper or spun-yarn soon decay. Put wire round the stay-pin of the link next abaft the first shackle, again round that of the second link next abaft the second shackle, round that of the third link next abaft the third shackle, and so on. Thus in heaving in the number of an incoming shackle, or at any time, the quantity of cable that is out can be known.

Put the cables in the lighter with their anchor ends at the bottom, ranging them side by side, and place all the slips and small gear separate. Lay the lighter across the bows, and take the cables in through the inner hawse holes, with double whips led along the deck outside the bitts.

The cable ends are secured to chain strops (necklaces) which in sailing ships go round the heel of the main mast.

Chain slips, long enough to reach to the top of the lockers, are shackled to the necklaces; the slips are stopped up and down the sides of the lockers, and when the ends of the cables are connected to the slips, and the tongues of the slips lashed down, the cables are faked away in the lockers. The ends of the cables must be passed down through the compressors, so as to control the cables in their descent.

In steam ships (the shaft interfering with such an arrangement as we have described), the slips are secured to ring bolts in the sleepers on each side, and then triced up as above. The object for doing so is, that the end of one cable may be slipt altogether, or connected with another without disturbing the whole locker.

The gangers, and cable enough for bending, are left on deck.

The stream chain has generally a separate locker.

The messenger is run round the capstan and manger rollers, *the turns taken* out, the after bight placed on the sprockets, and *the rollers* being at their aftermost positions, the ends are

adjusted as to length, and connected with a peculiar splicing shackle.

The manger rollers are moveable, so that they may be adapted to the gradual stretch of the messenger.

If the Anchors are in a separate vessel from the cables, put the gangers along with the anchors, and place the waist anchors with their stocks on end. Should the stocks have been already cleated, let the upper arms be upwards. Rig both davits on the same side; one in the fore part of the fore chains for fishing the bower, and the other about half the length of the shank before the after bill board for the waist anchor.

The *Fish davit* is rigged with a long tackle lashed to the mast-head pendant, and hooked to the middle eye bolt in the head of the davit as a topping lift; a large double and double stropt block, and another single and single stropt, both having eyes large enough to go over, are placed on the davit end. The eyes of the fore and the after guys are then put over, and the ends set up taut with a lanyard.

The *Fish block* is double, double stropt into a large hook, and dragged into its place when at its work by the *back* rope. The fish fall is rove from inboard through the single block on the davit end and full through the others, the standing part being made fast to the fish block. In some fitments the hauling part of the fish fall is carried to the mast-head, a luff is placed from a bolt underneath on the bends to the davit ends as a martingale, and when the latter tackle is eased, the fall answers the purpose of a topping lift. These are the usual methods of *rigging the davit;* but when it is erected elsewhere than under the direct support of a mast, it is differently fitted.

For the *Waist anchor.*—Rig the davit head with fore and aft guys, a three-fold block for the purchase, and a runner block for the topping lift. If there be no good place for a step, form one with cleats. Reeve the runner, place the davit, lashing the heel slackly so as to allow for topping; make the runner and tackle fast on the opposite side of the deck, reeving its fall through a lead, and belaying abaft. Reeve the purchase with a piece of rope as large as the cat fall, using another three-fold block. Make the standing part fast to the davit-head, and lead the hauling one across the deck through a lead aft. Steady up the guys and lash the lower purchase block on the upper side of the

shank about half way from the crown, the crown of course being aft. If the yards are up, their tackles are useful on each end of the anchor to steady it and keep it square; if not, any tackle outside the fore rigging on the upper stock will do. If on weighing, the anchor is not well poised, it must be relashed. When it is up high enough, the fall is belayed, the davit topped by the runner, the stock and shank painters are passed and bowsed to, the tumblers are raised and placed under the shank, and the anchor lowered on them and secured, keeping the edge of the flue well on the bill board. The upper arm is confined by a slip lashing, and a tripping strop is passed round the lower one.

If the ganger is in the lighter, it will save trouble to bend it before hauling ahead.

For the *Bower anchor*—the cat-fall is rove from inboard, through the *foremost* sheave in the cat-head, the *foremost* in the cat-block, and so on full.

The cat-block is iron bound, three-fold, with a standing large hook; and the fall is first rove through its fore side, that the other parts may not ride whilst hauling them through, when the tackle is led forward.

The *Cat* is hooked to the ring of the anchor, the fish to the inner flue, and a tackle put on the upper stock. Whichever way the anchor lies in the lighter, unless it is raised by the tackles simultaneously, the vessel will be stove. When high enough, the topping-lift brings the flue on the bill-board, and the cat-stopper and shank painter are passed. All these stoppers or painters should be passed so that, when let go, their ends will be thrown downwards; else they will sometimes come inboard with a most dangerous jerk.

The *cat* and *fish* are unhooked, and a similar operation performed on the other side.

The bower chains are hauled out of the inner hawse holes by hawsers led through leading blocks made fast on the stock of their anchors, and shackled on to the rings.

The object of the stock-tackle is to throw the lower end of the stock off the bow, otherwise, it would turn inwards, over the slack cable, and the anchor would come up *foul*. The omission of this essential duty in stowing an anchor has interfered with many a passing certificate.

Stream anchors are conveniently stowed when placed flat on the deck amidships at the bows of the boom boats; anywhere but on the sheet anchors. They are usually carried out by a boom boat; and when the tackles have hoisted the boat out, the main yard and fore-stay are immediately available for hoisting out the anchor.

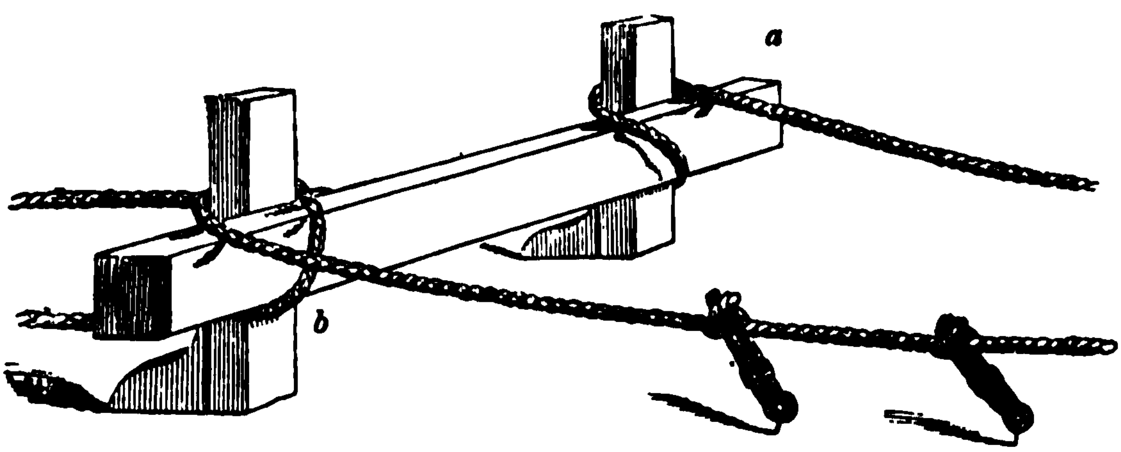
The outer ends of the gangers being shackled to the waist anchors, the inner ones are hauled in through the *outer hawse* holes, and are secured inboard, being thus ready for connection with a third or fourth cable when requisite.

The lashing of a ganger carried away in a first rate when at sea in a gale; the bucklers and hawse plugs were dragged out, and a serious amount of water shipped before the mischief was remedied.

The bights of the gangers are stopped up outside, clear of the ports.

The buoys and buoy ropes are now put on the anchors; the bower cables are hauled in taut and bitted. Thus, hook a block to the eye-bolt which is over the bitt head, reeve a hook rope in it, and hook on the cable a little abaft the *cross piece* of the bitts. A few careful observations will teach the very link that should be hooked. Light forward the chain; trice up the bight, letting the after part fold over to the side on which the cable is, and then throw it over the bitt head, as in *figure* 167; the starboard cable, *a*, being *with the sun*, and the port cable, *b*, being against the sun.

Fig. 167.



The object of the buoy is to indicate the position of the anchor when on the bottom; and the buoy rope is supposed to be equal to weighing the anchor, in the event of the ship having

slipped, or the cable having *parted*. Care is taken that th buoy rope is not longer than is necessary to let the buoy *watc* at the highest time of tides where used.

Hemp cables are usually made with a shackle spliced into on end, and it is well to fit the other in a similar manner. (*Fig* 166.)

When supplied with splicing tails, the end is unlaid for some distance; and, after leaving length enough for the tails, laid u again. It is now open enough in the strands to admit of being fidded out for splicing. Put a seizing on at the place from whence it is unlaid, open the strands of the tails, taper and plait them down, finishing with a piece of rope. The chain tails are puddened, and hitched down; then proceed with the chain and rope tails as with a common splice, expending the ends along the lay of the cables, and seizing them down.

Coil hemp cables, both in the lighter and tier, right handed, clenching the lower end in the heart of the tier to a chain strop round a beam, and lashing down to an adjoining one.*

CHAP XIV.

STORES AND PROVISIONS.

HOISTING IN SPARE SPARS.

Topmasts of large ships weigh as much as three tons, and should therefore be hoisted in with the yards and stays.

If the fore ends of spars take the fore rigging or backstays, a pull on the after main brace will clear them; but as a general rule, it is a sign of indifferent contrivance, and it certainly is unsafe to touch braces when yards are bearing weights.

In slinging spars alongside, wet and its consequences may be avoided by running a large hoop up on the spar, stopping the end of the slings, or lashing to it, and turning it round.

* In fitting out and paying off, large ships are sometimes placed at moorings where they take the ground at very low water; so that unless allowance be made for this possibility, whilst lashing lighters for the night, if the ship should ground, the timbers are either torn out of the lighter, or else lashings are carried away, and she gets adrift.

Booms should be secured with strops having lashings at each end; certainly on one end; long lashings passed turn by turn are very tedious, both in securing and casting loose.

In hoisting in spars that are in the water, it is sometimes not easy to see that the tackles are properly hooked to the strops. Accidents have happened by hooking the stay to one bight of a strop passed twice round the spar, and the yard tackle to the other bight. All goes well whilst there is an equal strain on each tackle, but on easing in the yard, the spar rolls suddenly out of the strop. The heel of a top-mast went through the planks of the deck of the * * * * in this way.

Provisions, water casks, &c. are usually hoisted in by the "quarter" tackle and small stay. Jammed fingers on deck, broken heads in the lighter or launch, the paintwork outside, and gang boards, will all be saved by working the lower block of the tackle with a light tricing whip on the yard. The stay hooks to the cap with a lizard on the main-stay, so as to overlook the hatchway.

It is well to fit the lower block with a second strop for the quarter, which may thus be unhooked before lowering down the hatch.

In putting on a whip for the quarter, it should be on the lift, and bent on the pendant some distance down, having the hook stopt above the bend. The heavier the lower block of the quarter the better, as it will overhaul down more easily.

In hoisting in water casks that have been rafted, lift them with can-hooks into the stern sheets of a boat; then sling them, and much delay will be avoided.

In starting water, it may be of consequence to remember the curious fact in hydraulics, that more water issues from a vessel through a short pipe, than through a simple aperture of the same diameter with the pipe; and still more will come if the pipe be funnel shaped, or wider towards its inner extremity.

All lime should be slaked before being received on board. In completing *provisions* and *stores*, when stronghanded, the more lighters that can be had the better. Every yard davit, or other projection may have a whip, and especial working party. The lighters must, however, be stowed with reference to this simultaneous clearance, so that there may be no delay in waiting for articles *that should* be stowed in certain order in the holds.

Each *cask* has its contents and date of package marked on it; and the provisions are stowed in such proportions that one day's allowance of every kind can be got out without *breaking bulk.* The newest sort are placed lowest, and all casks are stowed *bung up.* Billets of wood ("Dunnage") are packed under the "*chines,*" so that not only is the whole stowage made secure from the danger of shifting, but a sufficiency of fuel for the ovens is daily forthcoming.

A press of work such as this, unavoidably affords opportunities for trickery; and as in the early history of a ship there are always some who are more skilful with a gimlet and piece of straw, than with a marlingspike and piece of rope, spirit casks should be struck down and secured in the spirit room without a moment's delay.

A young officer will find stowage of holds to offer a suitable opportunity for learning the use of bale and butt slings, can-hooks, levers, wedges, &c., besides being very useful in carrying out the orders against naked lights.

The keys of all store rooms are kept in the first lieutenant's cabin, and are supposed to be absent from thence *only during the actual issue* of stores. In ships where the bread room has been made a mess place, and the fore store-rooms a lounging place for idlers, the natural consequences have been foul air, dirt, and danger. From such causes, the * * * was twice on fire during one commission.

The engineers' stores are in such constant demand when under steam, that their store-room must be kept open: but it must be remembered that hemp or cotton, &c. with oil and lamp black, &c. (such as "*wipes,*" for instance), generate heat, and will eventually ignite spontaneously on exposure to air.

When the lamps are kept in order, oil "lights up" better than candles. A pint of good oil will burn eleven hours in an argand lamp, and give light equal to that of three six-mould candles.

Admiralty, 1st Jan. 1842.

List of the average Contents and Weights of the different Packages and Iron Tanks usually supplied to Her Majesty's Ships.

PROVISIONS AND VICTUALLING STORES.

Description.	Packages.	Contents.	Average. Gross.	Average. Tare.	Average. Net.	Measurement in Cubic Feet
		lbs.	lbs.	lbs.	lbs.	Casks are thrown into Tonnage by a Scale.
Biscuit -	Bag	112	114	2	112	
		Gals.				
Rum -	Puncheon	72	804	142	662	
	Hogshead	54	615	119	496	
	Barrel	36	420	90	330	
	½ Hhd.	25	293	63	230	
	Kilderkin	18	213	47	166	
	Small Cask	12	142	32	110	
White Wine	Hogshead	54	634	106	528	
	Barrel	36	426	74	352	
	½ Hhd.	25	306	63	243	
	Kilderkin	18	223	47	176	
	Small Cask	10	130	32	98	
		8 lb. pieces.				
Salt Beef	Tierce	38	502	198	304	
	Barrel	26	355	147	208	
		4 lb. pieces.				
Salt Pork	Tierce	80	513	193	320	
	Barrel	52	341	133	208	
		lbs.				
Flour -	Barrel	336	388	52	336	
	½ Hhd.	250	294	44	250	
	Kilderkin	168	201	33	168	
Suet -	½ Hhd.	168	333	165	168	
	"	150	339	189	150	
	Kilderkin	115	250	135	115	
	Small Cask	70	184	114	70	
	"	56	132	76	56	
Raisins	Barrel	336	388	52	336	
	½ Hhd.	224	266	42	224	
	Kilderkin	168	200	32	168	
	Small Cask	112	140	28	112	

Description.	Packages.	Contents.	Average.			Measurement in Cubic Feet.
			Gross.	Tare.	Net.	
		Bus.	lbs.	lbs.	lbs.	Casks are thrown into Tonnage by a Scale.
Peas -	Barrel	5	376	54	322	
	$\frac{1}{2}$ Hhd.	$3\frac{6}{8}$	283	43	240	
	Kilderkin	$2\frac{4}{8}$	193	32	161	
Oatmeal	Barrel	$7\frac{1}{8}$	414	54	360	
	$\frac{1}{2}$ Hhd.	$5\frac{1}{8}$	307	44	263	
	Kilderkin	$3\frac{6}{8}$	213	32	181	
	Small Cask	$2\frac{1}{8}$	146	26	120	
	"	2	121	20	101	
		lbs.				
Sugar -	Barrel	392	465	73	392	
	$\frac{1}{2}$ Hhd.	280	339	59	280	
	Kilderkin	168	216	48	168	
	Small Cask	140	173	33	140	
	"	112	142	30	112	
Chocolate	$\frac{1}{2}$ Hhd.	108	135	27	108	
	Small Cask	55	71	16	55	
Tea -	Chest	83	109	26	83	
	$\frac{1}{2}$ Chest	36	52	16	36	
		Gals.				
Vinegar -	Puncheon	72	864	140	724	
	Hogshead	54	662	119	543	
	Barrel	36	450	88	362	
	$\frac{1}{2}$ Hhd.	25	317	65	252	
	Kilderkin	18	230	49	181	
	Small Cask	12	152	32	120	
		lbs.				
Tobacco -	Hogshead	242	330	88	242	
	Barrel	160	225	65	160	
	$\frac{1}{2}$ Hhd.	126	180	54	126	
	Kilderkin	83	121	38	83	
Soap -	Barrel	244	289	45	244	
	$\frac{1}{2}$ Hhd.	113	141	28	113	
	Small Cask	55	72	17	55	
Lemon Juice	Case	72	183	111	72	
	$\frac{1}{2}$ Case	36	93	57	36	
		No.				
Tongues	Small Cask	36	200	65	135	
	"	24	168	78	90	
	"	18	146	79	67	
	"	12	92	47	45	

EMPTY CASKS, ETC.

Description.	Packages.	Average.			Measurement in Cubic Feet.
		Length inches.	Capacity in Gals.	Weight lbs.	
Tight Water Casks.	Leager	59	164	270	Thrown into Tonnage by a Scale.
	Butt	53	110	176	
	Puncheon	41	72	144	
	Hogshead	37	54	108	
	Barrel	31	36	80	
	½ Hogshead	28	25	62	
	Kilderkin	25	18	53	
	Small Cask	...	12	34	
	„	...	8	24	
	Barricoe	...	10	25	
Mess Utensils	Kit	...	$1\frac{6}{8}$	6	
	Keg	...	$1\frac{3}{8}$	6	
	Can	...	$1\frac{5}{8}$	6	
	Barricoe	...	$5\frac{1}{8}$	16	
Bread Casks	To hold 56 lbs.	...	16	30	
	„ 30	...	12	25	
	„ 20	...	10	21	
Lemon Juice	Cases, whole	...	...	42	
	„ half	...	...	24	
Biscuit Bags	Large	...	...	2	
	Small	...	...	1½	

SLOP CLOTHING.

Description.	Packages.	Contents.	Average. Gross.	Average. Tare.	Average. Net.	Measurement in Cubic Feet. ft.	in.
	Bale	No.	lbs.	lbs.	lbs.	ft.	in.
Blue Cloth Jackets, No. 1. A. - -	Large	50	163	3	160	7	6
	Small	25	81	2	79	3	7
Do. No. 1. B. -	Large	50	119	3	116	6	2
	Small	25	59	2	57	3	5
Do. No. 2. - -	Large	50	139	3	136	8	0
	Small	25	71	2	69	4	7
		Pairs.					
Blue Cloth Trowsers, No. 1. - -	Large	50	108	2	106	6	2
	Small	25	53	1½	51½	3	3
Do. No. 2. - -	Large	50	108	2	106	6	2
	Small	25	53	1½	51½	3	3
		Yards					
Blue Cloth in the piece, for Jackets, No. 1. - -	Large	69	149	3	146	6	2
	Small	34½	75	2	73	3	2
Do. in the piece, for Trowsers, No. 1.	Large	67	112	3	109	5	5
	Small	33½	56	2	54	2	9
Do. in the piece, for Jackets, No. 2. -	Large	64	169	3	166	8	1
	Small	32	84	2	82	4	2
Do. in the piece, for Trowsers, No. 2.	Large	62	116	3	113	5	6
	Small	31	58	2	56	2	10
Duck in the piece	Large	296	189	3	186	4	10
	Small	148	93	2	91	2	6
Flannel in the piece	Large	230	75	3	72	5	3
	Small	115	37	2	35	2	9
		No.					
White knitted Worsted Jackets	Large	50	69	3	66	5	4
	Small	25	35	2	33	2	10
White wove Worsted Jackets	Large	50	57	2	55	3	7
Blue wove Worsted Jackets	Large	50	54	2	52	4	0
	Small	25	27	1½	25½	2	4
		Pairs					
Stockings - -	Large	150	70	2	68	4	4
	Small	100	47	1½	45½	3	0
	"	75	36	2	34	2	9
Mits - - -	Small	100	42	2	40	2	7
		No.					
Worsted Caps -	Large	100	53	2	51	3	7
	Small	50	30	1	29	2	0

SLOP CLOTHING. (*Continued.*)

Description.	Packages.	Contents.	Average. Gross.	Tare.	Net.	Measurement in Cubic Feet.
	Bale.	Yards.	lbs.	lbs.	lbs.	ft. in.
Blue Baize in the piece - - -	Large	80	85½	1½	84	6 3
Blue Serge Frocks -	Small	No. 25	33½	½	33	1 8
Blue Serge in the piece - - -	Small	Yards. 80	33½	½	33	1 8
Blankets - -	Large	No. 25	115	3	112	9 0
Shirts - - -	Large	100	102	2	100	4 4
	Small	50	52	2	50	2 6
Handkerchiefs -	Small	100	8½	½	8	0 4½
Caps, for Boats' Crews - -	Case. Large	100	...	...	...	7 4
	Small	50	...	...	...	3 7
Shoes - - -	Barrel	Pairs. 100	199	73	126	
	½ Hhd.	50	122	63	59	
Flushing Jackets -	Bale. Large	No. 25	129	3	126	9 6
Do. Trowsers - -	,,	Pairs. 25	87	3	84	6 9
Flushing in the piece for Jackets - -	,,	Yards. 48	143	3	140	8 7
Flushing in the piece for Trowsers -	,,	30	102	3	99	5 10
BOYS' SLOPS.						
Blue Cloth Jackets	Large	No 50	104	2½	101½	5 6
	Small	25	52	2	50	3 5
Blue wove Jackets -	,,	50	33	2	31	2 2
White knitted do.	,,	50	53	2	51	2 11
Shirts - - -	,,	100	80	2	78	4 1
Shoes - - -	½ Hhd.	Pairs. 50	93	50	43	
Hair Bed - -	...	No. 1	9¼	½	7¾	1

MARINE NECESSARIES.

Description.	Packages.	Contents.	Average.			Measurement in Cubic Feet.
			Gross.	Tare.	Net.	
		No.				
Foraging Caps	Barrel	100	115	57	58	
	Bale. Large	50	32	2	30	3 0
	Small	12	8	1	7	2 0
Gray Cloth Trowsers in materials	Pairs. Large	12	28	1	27	1 1
	Small	6	14	1	13	0 7
Half-Boots	Barrel	50	187	73	114	
	½ Hhd.	25	98	50	48	

FORAGE.

Hay in bundles : 4½ lbs. per cubic foot.

Trusses supposed to weigh 56 lbs., but vary from 52 to 58 lbs.

Straw in bundles $3\frac{1}{10}$ lbs. per cubic foot, vary from 30 to 40 lbs.

Oats, 3·64 cubic feet per cwt.

Barley, 2·38 do.

Wheat, 2·36 do.

RELIGIOUS BOOKS.

Description.	Packages.	Contents.	Average.			Measurement in Cubic Feet.
			Gross.	Tare.	Net.	
		No.	lbs.	lbs.	lbs.	ft. in.
Bibles	...	10	...	...	28	0 7
Prayer Books	...	10	...	...	9	0 2
Psalters	...	10	...	...	4	0 1
Testaments	...	10	...	...	9	0 3
Library Books	Sets. Large	318	253	60	193	7 11
	For Frigates	173	148	35	113	4 8
	Small	111	126	30	96	3 10

IRON TANKS.

Description.		Capacity in Gallons.	Weight when empty.			Measurement in Cubic Feet.	
			cwt.	qrs.	lbs.	ft.	in.
Whole	No. 1 - -	600	10	1	14	98	3
	„ 2 - -	500	8	2	16	82	0
	„ 3 - -	400	6	3	25	65	8
Half	„ 4 New -	200	4	2	25	33	2
	„ 5 Rider	200	4	2	25	33	2
	„ 6 Flat -	193	5	1	20	32	4
	„ 7 Old -	200	4	1	24	32	10
Quarter	„ 8 - -	100	2	3	20	16	6
	„ 9 Rider	100	2	3	20	16	6
Bilge	„ 10 Large	375	6	2	25	61	8
	„ 11 Old	264	5	2	2	43	9
	„ 12 Small	110	3	0	6	18	9
Bread Tanks - -		...	Weight to be given when issued.				
Tanks made to mould		...					
Iron Tar Casks		27	0	2	19		
		13	0	1	12		
		7	0	1	8		

Water is computed at 210 gallons per ton.

Weight of Provisions and Stores complete for a Ship of each Rate.

Number of Guns - -	120				90				80			
Number of Men - -	1000				880				750			
	tons.	cwt.	qrs.	lb.	tons.	cwt.	qrs.	lb.	tons.	cwt.	qrs.	lb.
Provisions for four months	142	17	3	0	117	4	3	0	107	4	2	0
Tare - - - - -	25	13	1	0	29	16	2	0	26	16	0	24
	4 months.				4 months.				4 months.			
Water - - - -	500	0	0	0	410	0	0	0	375	0	0	0
Tare - - - -	100	0	0	0	82	0	0	0	75	0	0	0
Anchors and Stocks - -	26	8	0	0	24	12	0	0	22	12	2	0
Chain and hempen cables -	77	0	0	0	75	5	0	0	67	9	2	0
Wood- - - - -	30	0	0	0	27	0	0	0	25	0	0	0
Coals - - - - -	92	0	0	0	80	0	0	0	65	0	0	0
Marine and Medical Stores	6	4	1	27	5	2	0	7	4	4	2	0
Purser's slops and necessaries - - - -	7	15	3	0	6	10	0	0	5	11	2	0
Seamen and their effects, including officers' stores	137	10	0	0	119	15	0	0	103	2	2	0
Bowsprits - - - -	13	5	0	0	12	18	0	0	10	12	0	0
Fore-masts, yards, &c. -	33	15	0	0	33	4	0	0	28	5	3	0
Main-masts, yards, &c. -	45	10	0	0	44	9	0	0	37	17	3	0
Mizen-masts, yards, &c. -	15	0	0	0	14	17	2	0	12	11	2	0
Spare gear - - - -	19	2	0	0	19	2	0	0	17	13	0	0
Rigging and blocks - -	67	16	0	0	65	18	2	0	63	10	0	0
Sails, complete - - -	13	11	2	0	12	17	0	0	12	13	1	0
Boats and their gear -	10	7	2	9	10	2	1	17	10	2	1	17
Boatswain's and carpenter's stores - - - -	97	1	2	0	63	6	0	0	63	5	0	0
Firehearth - - - -	13	14	1	24	9	6	1	7	7	6	2	10
Armament complete, including gunners' stores -	603	16	1	0	498	1	1	0	411	3	3	0
Total - - - -	2088	7	1	4	1774	8	1	3	1572	12	0	23

Weight of Provisions and Stores complete for a Ship of each Rate.
(Continued.)

Number of Guns - -	70	50	40	26
Number of Men - -	650	500	350	230
	tn. ct. qr. lbs.	tn. ct. qr. lbs.	tn. ct. qr. lbs.	tn. ct. qr. lbs.
Provisions for four months - - -	92 18 2 0	71 9 2 0	50 0 3 0	32 17 2 0
Tare - - - -	23 4 3 0	18 2 2 0	12 12 3 1	8 7 0 0
	4 months.	4 months.	14 weeks.	14 weeks.
Water - - - -	325 0 0 0	250 0 0 0	153 0 0 0	86 5 0 0
Tare - - - -	65 0 0 0	50 0 0 0	30 4 0 0	17 5 0 0
Anchors and Stocks -	21 12 0 0	18 14 2 0	15 3 3 0	9 16 0 0
Chain and hempen cables - - -	66 6 0 0	59 0 2 0	45 3 2 8	29 18 0 0
Wood - - - -	20 0 0 0	15 0 0 0	10 0 0 0	5 0 0 0
Coals - - - -	55 0 0 0	30 0 0 0	20 0 0 0	11 0 0 0
Marine and Medical Stores - - -	4 1 2 14	3 8 0 0	2 9 1 0	1 11 2 0
Purser's slops and necessaries - - -	4 18 0 0	3 15 0 0	3 1 1 18	2 8 3 0
Seamen and their effects, including officers' stores - -	89 7 2 0	68 15 0 0	48 2 2 0	31 12 2 0
Bowsprits - - -	10 3 2 0	8 19 2 0	6 12 1 0	4 2 2 0
Fore-masts, yards, &c.	24 14 1 0	22 0 1 0	17 17 0 0	10 17 1 0
Main-masts, yards, &c.	33 6 3 0	29 7 3 0	22 19 1 0	14 19 3 0
Mizen-masts, yards, &c.	11 4 2 0	9 19 0 0	7 16 2 0	4 16 2 0
Spare gear - - -	14 6 0 0	13 7 2 0	9 11 0 0	6 5 3 21
Rigging and blocks -	59 3 1 0	56 14 2 9	47 9 0 0	28 8 3 0
Sails, complete - -	11 18 3 0	11 3 2 20	9 7 1 0	5 19 1 0
Boats and their gear -	10 2 1 17	8 17 2 23	8 17 2 23	7 14 1 16
Boatswain's and carpenter's stores - -	83 5 0 0	66 1 2 7	66 1 2 7	35 10 0 0
Firehearth - - -	6 19 2 10	4 16 1 12	3 16 3 0	3 0 1 7
Armament complete, including gunners' stores - - -	360 15 1 0	270 11 3 0	205 5 3 0	105 8 1 0
Total - - -	1393 7 2 13	1090 4 2 15	775 12 0 1	463 4 0 16

Weight of Provisions and Stores complete for a Ship of each Rate.
(Continued.)

Number of Guns - -	18	16	12	8
Number of Men - -	175	150	130	80
	tn. ct. qr. lb.	tn. ct. qr. lb.	tn. ct. qr. lb.	tn. ct. qr. lb.
Provisions for four months - - -	25 0 1 0	18 17 2 0	18 11 2 0	11 8 3 0
Tare - - - -	6 12 2 0	4 14 2 0	4 14 2 0	3 19 1 0
	12 weeks.	12 weeks.	10 weeks.	8 weeks.
Water - - - -	65 12 0 0	48 15 0 0	40 0 0 0	20 0 0 0
Tare - - - -	13 2 2 0	9 7 0 0	8 0 0 0	4 0 0 0
Anchors and Stocks -	8 9 1 0	6 17 1 0	5 13 1 0	4 1 3 0
Chain and hempen cables - - -	23 11 0 1	19 15 3 0	16 18 0 11	14 4 1 0
Wood - - - -	4 0 0 0	3 0 0 0	2 10 0 0	2 0 0 0
Coals - - - -	10 0 0 0	10 0 0 0	9 0 0 0	8 0 0 0
Marine and Medical Stores - - -	1 0 3 7	0 15 0 0	0 15 0 0	0 9 0 0
Purser's slops and necessaries - - -	2 1 2 0	1 15 0 0	1 12 3 0	0 18 3 0
Seamen and their effects, including officers' stores - -	24 1 1 0	17 17 2 0	17 17 2 0	11 0 0 0
Bowsprits - - -	3 4 3 0	2 18 0 0	2 5 0 0	1 11 3 0
Fore-masts, yards, &c.	9 14 0 0	8 4 0 0	6 13 0 0	5 1 0 0
Main-masts, yards, &c.	12 18 3 0	10 5 0 0	8 10 0 0	6 9 0 0
Mizen-masts, yards, &c.	4 6 1 0			
Spare gear -	6 0 2 0	4 6 1 0	3 12 0 0	2 9 0 0
Rigging and blocks -	22 1 1 8	15 5 3 0	13 0 3 0	9 12 1 0
Sails, complete - -	4 18 3 0	4 0 2 0	3 13 1 0	2 19 1 0
Boats and their gear -	2 17 2 8	2 9 2 0	2 9 2 0	1 6 1 0
Boatswain's and carpenter's stores - -	35 10 0 0	19 2 0 0	19 2 0 0	12 7 0 0
Firehearth - - -	2 16 1 8	2 6 0 21	2 6 0 21	1 14 0 0
Armament complete, including gunners' stores - - -	80 3 2 0	64 12 3 0	40 8 3 0	16 4 1 0
Total - - -	369 2 2 24	265 5 1 21	227 13 0 4	138 15 2 4

From Fincham's Outlines of Ship Building.

CHAP XV.

ORDNANCE.

Guns are composed of *Iron* or *Gun metal*. Iron guns, being less expensive than others, are used where lightness is not of consequence.*

Gun Metal is an alloy of 10 parts of tin to 88 of copper. *Bronze* is an alloy of 11 parts of tin to 100 of copper; and bell metal consists of 22 parts of tin and 78 of copper.

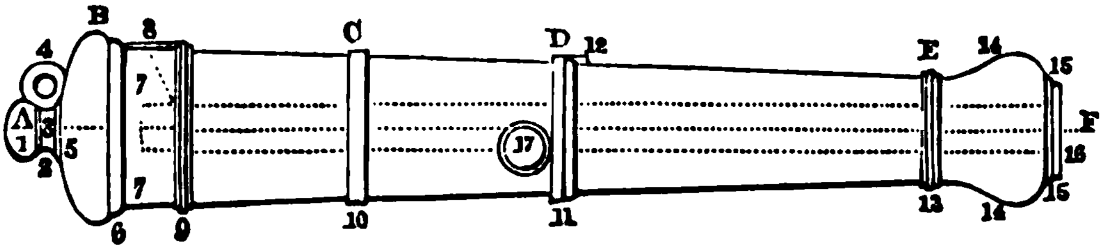
Iron ordnance is valued at about 15*l.* per ton, and Gun metal at about 4½*d.* per lb.

Guns are distinguished from each other by the nature of their metal and weight of their shot.

All guns are cast solid.

A gun is divided into five principal parts, viz. the cascable, first reinforce, second reinforce, chase, and muzzle. These as well as the minor divisions of both gun and carriage will be better understood by the adjoining sketches.

Fig. 168.



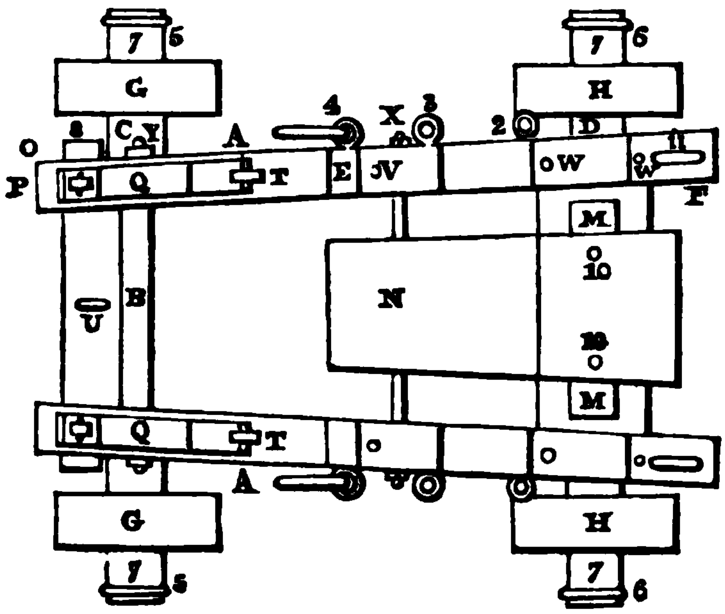
A B. Cascable.
B C. First reinforce.
C D. Second reinforce.
D E. Chase.
E F. Muzzle.

1. Button.
2. Button ring.
3. Neck.
4. Neck ring.
5. Neck fillets.
6. Base ring and ogee.
7. Vent field.
8. Vent patch and vent.
9. Vent astragal.
10. 1st reinforce ring.
11. 2nd ditto.
12. Dispart patch.
13. Muzzle astragal.
14. Swell of muzzle.
15. Muzzle mouldings.
16. Face of the piece.
17. Trunnions and trunnion shoulders.

* For much of the information presented in this chapter, the author is indebted to the "*Aide Mémoire.*"

The brackets, transoms, and trucks of ships' gun carriages are of elm: the axle-trees are of oak.

Fig. 169.



Parts of a Gun Carriage.

A. Side.
B. Transom.
C. Fore axle-tree.
D. Rear axle-tree.
E. Quarter rounds.
F. Steps.
G. Fore truck.
H. Rear truck.
K. Fore axle-tree cleat.
L. Rear ditto.
M. Stool.
N. Bed.
O. Horns.
Q. Cap square.
R. Trunnion box.
S. Eye bolt and key.
T. Joint bolt.
U. Breast loop.
V. Bracket bolt.
W. Rear axle-tree bolts.
X. Bed bolt and bar.
Y. Transom bolt and bar.
Z. Fore axle-tree stay.

1. Train loop.
2. Side loop and riveting plate.
3. do. do.
4. Breeching bolt and ring.
5. Fore axle-tree loop.
6. Rear axle-tree loop.
7. Linch pins.
8. Side cleat.
9. Dowel pins.
10. Stool bed bolts.
11. Rear loop.

Fig. 170.

External appearance.

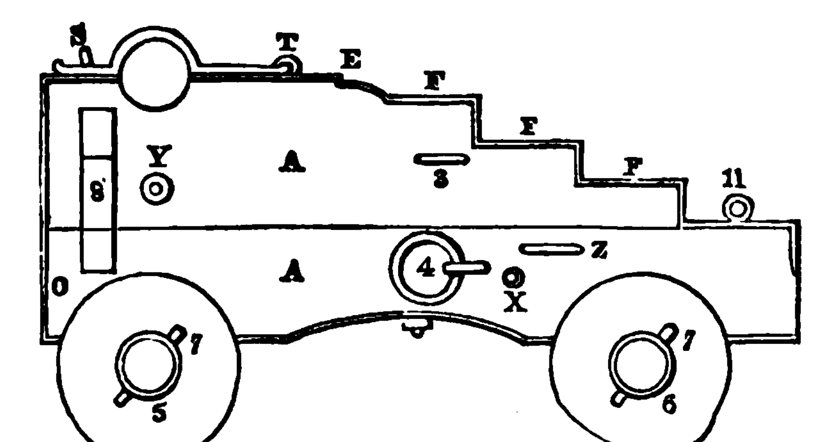


Fig. 171.

Internal appearance.

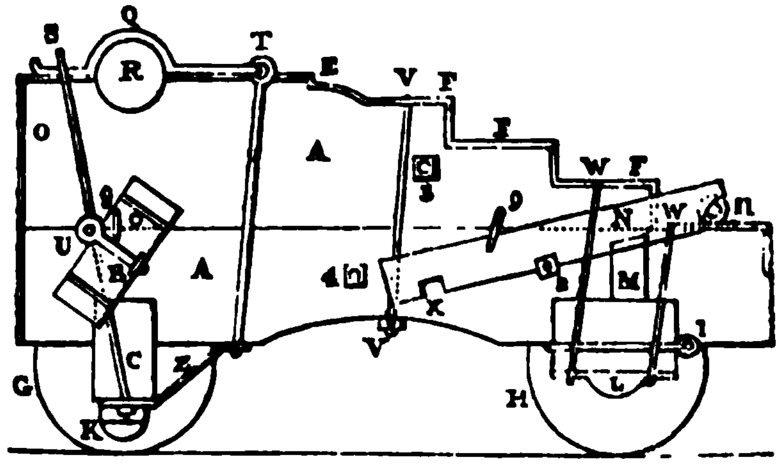
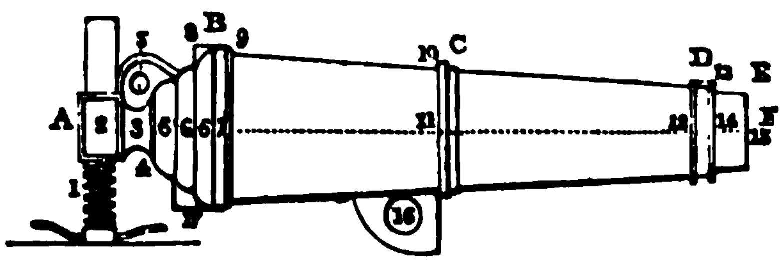


Fig. 172.



Parts of a Carronade.

A B. Cascable.
C D. Chase.
B C. Reinforce.
D E. Muzzle.
E F. Hash rim.

Rings, &c.

1. Elevating screw.
2. Ditto screw box.
3. Neck.
4. Neck fillets.
5. Breeching loop.
6. Breech mouldings.
7. Base ring and ogee.
8. Base patch.
9. Vent patch, pan, and vent.
10. Dispart and step sights.
11. Reinforce ring and ogee.
12. Muzzle mouldings.
13. Dove tail to receive dispart.
14. Muzzle mouldings.
15. Face of the piece.
16. Carronade loop.
17. Coin patch.

The carriage and slide of 68-pounders and 10-inch guns weigh about 33 cwt.; the common carriages about 9 cwt.

As the elastic force of the powder is greatest at the breach, that part of the gun is made largest; consequently the outside of the gun is not parallel to the axis of the bore; but if a line be drawn from the cascable along the top of the gun parallel with the axis of the bore, and a projection which will touch that line be fixed on the gun anywhere in the direction of the muzzle, it will be as easy to direct the bore towards an object, as if the gun were the same thickness everywhere. This projection is the Dispart, and *may be found by taking* the diameter of the base ring, and any

Fig. 173.

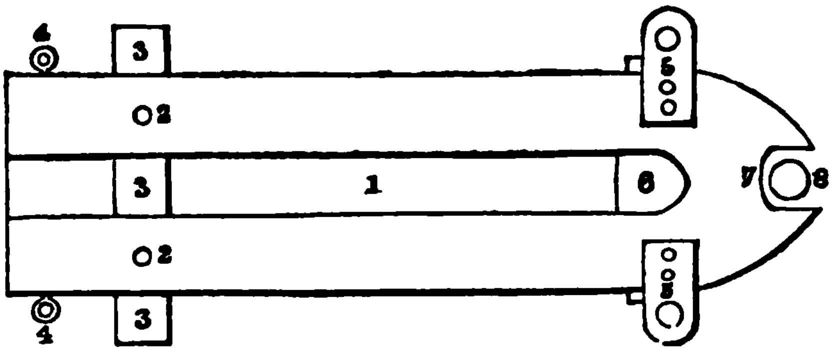
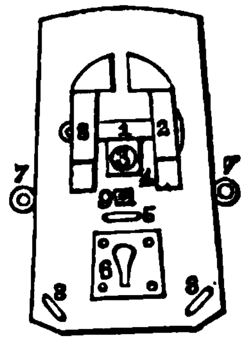


Fig. 174.



Slide. (*Fig.* 173.)

1. Groove.
2. Rear chock bolts.
3. Rear chocks.
4. Side loops.
5. Housing ears.
6. Fore chocks.
7. Horse shoe plate.
8. Fighting bolts.

Carriage. (*Fig.* 174.)

1. Joint bolt.
2. Joint chocks.
3. Pintail bolts.
4. Pintail plate.
5. Drop bolt.
6. Elevating screw plate.
7. Side loops.
8. Rear loops.
9. Nut of bolt for groove piece.

other part of the gun where it is desired to place the dispart, subtracting the less from the greater, half of which difference will be the height of the dispart on that part where the less diameter was taken. This may be done by taking the circumference with two pieces of thread, dividing each into three parts for the diameter, half the difference of these diameters being the required height.

Howitzers have no dispart; a patch on the muzzle making that part equal in height to the base ring.

The *Angle of Dispart* is that number of degrees which the axis of the bore would point above the object aimed at when laid by the surface of the gun.

The *Sights* are two notches cut on the upper part of the base ring and swell of the muzzle.

The *Line of metal* is an imaginary line drawn along the surface of the metal between the two sights.

The *Centre of metal* is indicated by notches on the side of the base ring and swell of the muzzle, corresponding with the axis of the piece.

The *Tangent scale* is marked with degrees for elevation, found by multiplying the length of the piece in inches from the base ring to the swell of the muzzle by 0·17455, the product giving *the length* of each nearly. By subtracting the *Dispart* from this *product, the* length of the tangent scale above the base ring for *one* degree of elevation will be obtained.

The *Calibre* of a gun is the diameter of its bore.

The *Axis of the piece* is the centre of the bore lengthways.

Windage is the difference between the diameter of the bore, and that of the shot.

The *Vents* of all ordnance are two-ninths of an inch in diameter.

The tabular length of guns is measured from the base ring to the muzzle, and is exclusive of the cascable. The 10-inch and 8-inch guns have the gomer, or conical chamber, and a less thickness of metal behind the charge than the 68-pounders and heavy shot guns, as may be observed by the place of their vent, which is in the base ring.

There are two descriptions of 10-inch guns, four of 8-inch guns, and three of 68-pounders. One calibre for each class; but the projectiles used in the 8-inch gun are not identical in the land and sea services, and necessitate different Tables for the two services.

The 10-inch hollow shot, or naval shell, weighs 82 pounds; it is made up to an average weight of 86 pounds for firing by filling with sand and plugging it. Same for land and sea.

The 10-inch shell for mortars weighs 86 pounds, and contains 4 pounds 13 ounces of powder; burster, 2 pounds 10 ounces.

The 10-inch naval shell weighs 82 pounds, and contains 5 pounds 9¼ ounces; burster, 5 pounds 8 ounces. The external diameter is 10″·01 greater than of the land shell, reducing the windage; the thickness of metal is 0″·296 less than of the land shell, hence the difference of weight. Hollow shot and shell for guns may be distinguished from shells for mortars by being made without ears.

The 8-inch hollow shot for land service, weighs about 47 pounds, being in fact the shell plugged; but for sea service 56 pounds.

The 8-inch land service shell weighs empty, 46 pounds; the naval shell weighs empty, 48 pounds; both contain the same bursting powder, namely: 2¼ pounds; the difference is in the diameter of shell and thickness of metal, which is 0″·065 greater for land than for sea service.

There are four calibres of 32-pounders; viz., three of 6″·41; one of 6″·375; five of 6″·35; and four of 6″·30.

There are three 24-pounders, having no diversity of calibre or projectile; but the calibre of the 24-pounder brass howitzer is 0·103 less than that of the iron 24-pounder.

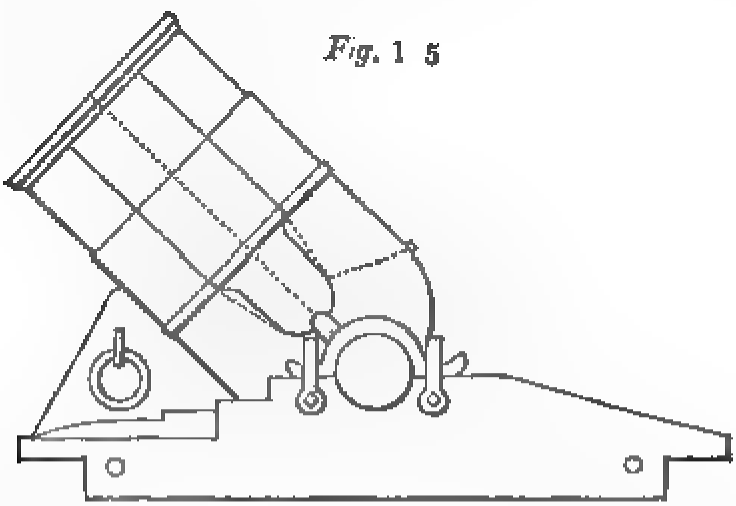
There are two calibres of 18-pounders; viz., two of 5″·292;

three of 5″·17. Both classes are in use for land or general service; these projectiles being alike for land and sea.

In the classes of 12-pounders (four), and 9-pounders (four), there is no diversity of calibre or projectile; but the calibre of the 12-pounder brass howitzer is 0·043 less than that of the iron or brass 12-pounder gun.*

Mortars differ from guns in being shorter, thicker, having the trunnions at the breech, and being used solely for the purpose of firing shell. They are distinguished by the diameter of the bore and weight of metal, and are mounted on a solid framing of timber called the *bed* (*fig.* 175.). Sea service mortars are heavier in proportion to the diameter of their bore than those for land service. The 13-inch sea mortar weighs 101 cwt., bed 83 cwt.; 10-inch, 52 cwt., bed 55 cwt.

Fig. 1 5



The strength of all ordnance is tested by firing heavy charges of powder and shot; as well as by hydraulic pressure.

PROOF CHARGES OF BRASS GUNS.

Gun - - - - pounder	12	9	6	3
Charge in pounds - - -	4	3	2	1

Brass mortars and howitzers are fired twice with their chambers full of powder, and with a shell — the former at an elevation of seventy-five degrees, the latter at twelve degrees. Iron mortars are fired with a charge equal to the full chamber, and with a solid shot whose diameter is similar to that of the shell.

* Hand-book, Field Service.

TABLE.—*Proof charges of the undermentioned Iron Ordnance.*

Nature.	Length.		Weight.	Charge.	
	ft.	in.	cwt.	lbs.	oz.
Guns, 10-inch	9	4	86	20	0
,, 8-inch	9	0	65	20	0
,, ,,	8	10	60	18	0
,, ,,	8	0	52	16	0
,, ,,	6	8½	50	14	0
,, 68-pounder	10	10	112	30	0
,, ,,	10	0	[illegible]	26	0
,, ,,	9	6	88	25	0
,, 56-pounder	11	0	98	28	0
,, ,,	10	0	87	25	0
,, 42-pounder	10	0	84	25	0
,, ,,	10	0	75	25	0
,, ,,	9	6	67	23	0
,, 32-pounder	9	6	58	21	8
,, ,,	9	6	56	21	8
,, ,,	9	7	64	21	8
,, ,,	9	0	46	12	0
,, ,,	8	0	48 to 50	21	8
,, ,,	9	0	50	18	0
,, ,,	8	6	45	16	0
,, ,,	8	0	42	14	0
,, ,,	8	0	41	12	0
,, ,,	7	6	40	12	0
,, ,,	7	6	39	12	0
,, ,,	6	6	32	10	0
,, ,,	6	0	25	9	0
,, ,,	5	4	25	9	0
,, 24-pounder	9	6	50	18	0
,, ,,	9	0	48	18	0
,, ,,	8	0	37	10	0
,, ,,	7	6	41	15	0
,, ,,	6	6	33	12	0
,, 18-pounder	9	0	42	15	0
,, ,,	8	0	38	15	0
,, ,,	7	0	22	7	0
,, ,,	6	0	20	7	0
,, ,,	5	6	15	6	0
,, 12-pounder	9	0	34	12	0
,, ,,	8	6	33	12	0

TABLE—*continued.*

Nature.	Length.		Weight.	Charge.	
	ft.	in.	cwt.	lbs.	oz.
Guns, 12-pounder -	7	6	29½	12	0
„ 9-pounder - -	8	6	28½	9	0
„ „ - -	7	6	26	9	0
„ „ - -	7	0	25	9	0
„ 6-pounder - -	8	6	23	6	0
„ „ - -	8	0	22	6	0
„ „ - -	7	6	21	6	0
„ „ - -	7	0	20	6	0
„ „ - -	6	6	18	6	0
„ „ - -	6	0	17	6	0
Carronades, 68-pounder	5	4	36	13	0
„ 42-pounder	4	6	22	9	0
„ 32-pounder	4	0	17	8	0
„ 24-pounder	3	9	13	6	0
„ 18-pounder	3	4	10	4	0
„ 12-pounder	2	8	6	3	0
„ 9-pounder -	4	0	8	2	4
„ 6-pounder -	2	9	4¾	1	8
Guns, 24-pounder -	6	0	20	6	0
„ 12-pounder -	6	0	21	10	0
„ 9-pounder - -	5	6	17	8	0
„ 6-pounder - -	4	11	11	5	0
Howitzers, 10 inches -	-	-	41	12	0
„ 8 inches -	-	-	21	8	0
„ 5½ inches -	-	-	15	6	0
Mortars, 13 inches -	-	-	100	20	11
„ 10 inches -	-	-	52	9	8
„ 13 inches -	-	-	36	9	0
„ 10 inches -	-	-	18	4	0
„ „ -	-	-	16¼	4	0
„ 8 inches -	-	-	9	2	0
„ „ -	-	-	8¼	2	0

GUNPOWDER.

The component parts of *Gunpowder* are 77 pounds of saltpetre, 10½ of sulphur, and 16 of charcoal, in every 100 pounds.

Cylinder powder is made from charcoal that has been burnt *in iron cylinders.* Pit powder, from that which has been burnt

in common pits. 1 pound of powder measures 32 solid inches. A cubic foot weighs 58 pounds.

Powder is marked thus: L. G., or large grain; F. G., fine grain; R. A., for rifle arms; R. S., re-stoved. Red characters denote the best quality; white, an inferior one.

Whole powder barrels contain 100 pounds; half barrels, 50; and quarter barrels, 25 pounds. Filled cartridges are stowed in cases; the wooden cases are square, copper-lined, the mouth being secured with a luted bung, as well as a lid. Those containing "*distant*" charges, are marked with black letters; those containing "*full*," with light blue; and those containing "*reduced*," with blue letters.

The cartridges are also known by their number of bands or "*hoops;*" the *distant* having three; the *full*, two; and the *reduced*, one hoop.

The metal cases are hexagonal, and are similar in contents and marks to the wooden ones. There are, however, some which for convenience in stowage at the bottom and sides of the magazine, are formed otherwise.

These cases are made of a composition of copper and tin.

Ball cartridge is packed in quarter barrels; and blank in half barrels.

The charges for heavy guns are usually about one-third of the shot's weight; for light guns about one-fourth; and for carronades from one-eighth to one-sixteenth.

Dimensions of Powder Packages.

Nature.	Whole.	Half.	Quarter.
	inches.	inches.	inches.
Barrel, depth - -	20	16	14
„ diameter - -	16	13	10
Case, length - -	17	13	10
„ breadth - -	17	13	10
„ depth - - -	20	17	14

Wooden cases cost about 1*l.* 15*s.* each.

Metal *cases about 1s. 2d.* per lb.

SHELL.

10-inch shell boxes are 12, 8-inch are 10, and 6-inch are 8 inches square. The bulk of 100 10-inch shell boxes is about 87, of 100 8-inch, 64, and of 100 6-inch, 38 cubic feet.

The fuse holes of shell fitted to receive metal fuses are bouched with gun metal, and are in such cases all of the same diameter.

Metal fuses are of three natures, viz., the 3-inch, which is driven with mealed powder, and will burn seven seconds; the 4-inch, which is driven with fuse composition, and will burn twenty seconds; and the short range, which is also driven with the composition, and will burn two seconds.

These have a metal screw cap; the fuse itself is screwed in to the left, and the cap unscrews in that direction.

Two of these fuses may be connected by cutting off the screws of the caps, and riveting or soldering their tops together, taking care to enter the longest one into the shell.

Fuse composition is made with 3 pounds 4 ounces of pulverised saltpetre, 1 pound of sublimed sulphur, and 2 pounds 12 ounces of *pit* mealed powder. One inch is supposed to burn in five seconds; but when driven with mealed powder they burn twice as much in the same time.

BLUE LIGHTS.

Blue lights are composed of 1 pound 12 ounces ground saltpetre, 7 ounces sublimed sulphur, and 2 ounces of red orpiment. One of these lights will burn half a minute.

LONG LIGHTS.

Long lights are composed of 7 pounds of ground saltpetre, 1 pound 12 ounces of sublimed sulphur, and 8 ounces of red orpiment. One of these will burn for six minutes.

SLOW MATCH.

Slow match is made with slackly laid up white hemp rope, which is dipped in a solution of lime water and saltpetre. One yard will burn for about three hours.

PORT FIRES.

Common port fires are composed of 2 pounds of sublimed brimstone, 1 pound of mealed cylinder powder, and 6 pounds of pulverised saltpetre. One of these, which is 16 inches long, will burn for fifteen minutes.

BICKFORD'S FUSE.

Bickford's fuse is a tube of powder sewn round with tarred twine; the outside being covered with pitch. It burns at the rate of twelve feet in five minutes, and is not to be extinguished even by water.

SIGNAL ROCKETS.

Signal rockets are composed of 4 pounds of pulverised saltpetre, 1 pound of sublimed sulphur, and 1½ pound of log-wood charcoal. They are of 1 pound and ½ pound.

CONGREVE ROCKETS.

Congreve rockets are driven on the same principle as signal rockets. Their case is of wrought iron, and may be used either as shot or shell rockets. In the latter case the fuse is adapted to the length of flight.

They occur as 24, 12, 6, and 3-pounders.

CARCASSES.

Carcasses are hollow shot perforated with three holes, filled with a composition made of 6·4 ounces of pulverised saltpetre, 2 pounds 8 ounces of sublimed sulphur, 1 pound 14 ounces of pounded resin, 10 ounces of pounded antimony, 10 ounces of tallow, and 10 ounces of turpentine. They are fired as are shell, and are almost inextinguishable, burning about ten minutes.

TUBES.

Common quill tubes are filled with a composition of mealed powder mixed with spirits of wine; the heads of detonating tubes with a composition of 230 grains of chlorate of potassa, the same quantity of antimony, and 73 grains of pulverised glass.

GUN COTTON.

Gun cotton is made by dipping common well cleaned cotton about thirty seconds in strong nitric acid, then placing it in water which is often renewed, in order to free the cotton from the acid with which it is impregnated. Care is then taken that all the knotty particles of the cotton are properly disentangled, and that it is properly dried. After this the preparation is ready for use, and may be exploded either by percussion, as fulminating, or ignition, as gunpowder.

Cotton in its unprepared state is Lignine, a compound of carbon, oxygen, and hydrogen; but after the action of the nitric acid, we find another element present, namely, nitrogen, a substance entering into the composition of nearly all our explosive bodies. After various experiments, it has been found that when used in great quantities, only one half of the equivalent weight of powder is necessary to produce the same results; but, although well adapted for mining purposes, it is, in consequence of its attendant dangers by friction, percussion, and heat, inapplicable to military purposes.

FIELD-PIECE CARRIAGES.

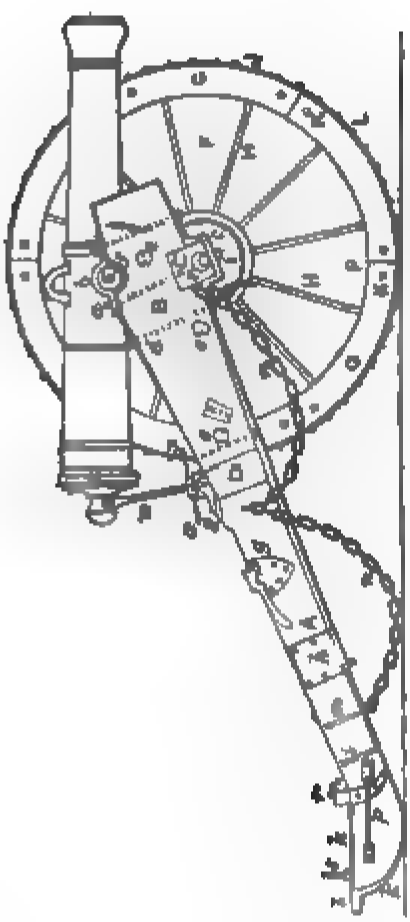
The field carriages for naval service are similar in construction to those for land service, but of smaller dimensions.

Table of their Weight, Dimensions, &c.

Weight of the - - -	24 pounder.			12-pounder, light.		
	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
Howitzer carriage, body - -	7	0	12	4	1	7
,, ,, wheels -	2	3	20	1	3	26
Howitzer limber, body - -	2	0	4	1	3	16
,, ,, wheels -	2	3	20	1	3	26
,, ,, ammunition	4	2	16	3	2	19
Number of rounds carried -	20			24		
Diameter of wheels (ft., inch.)	4	2		3	6	
Track from out to out (do.) -	4	2		3	8	

ELEVATION OF A 9-POUNDER BRASS FIELD CARRIAGE.

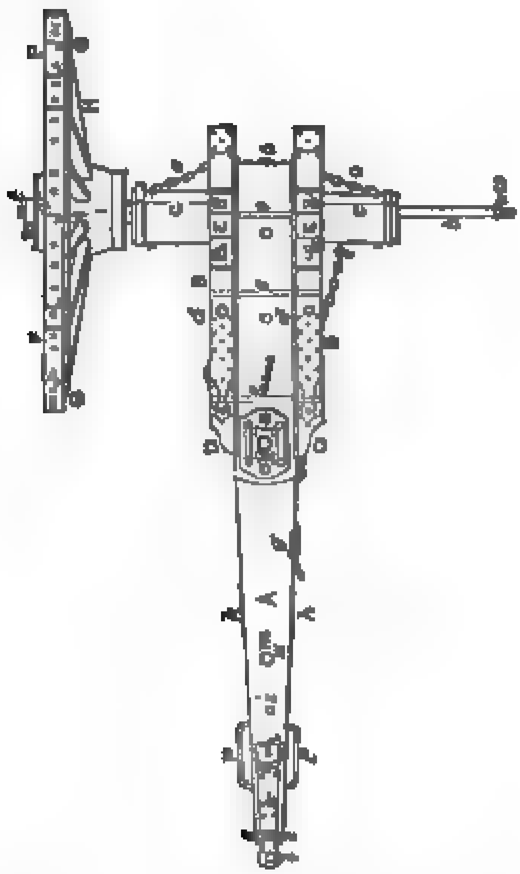
Fig. 176.



A. Block, or Trail.
B. Cheeks, or Brackets.
C. Axletree.
D. Ogee.
E. Trunnion holes.
F. Wheel.
G. Felly.
H. Spokes.
I. Nave.
J. Tire, or streak.
K. Rivets
L. Tire, or Streak bolts.
a. Eye, or Capsquare bolts.
b. Capsquares.
c. Axletree bands.
d. Bracket bolts.
e. Transom bolts.
f. Trunnion plates.

PLAN OF A 9-POUNDER BRASS FIELD CARRIAGE.

Fig. 177.



g. Portfire clipper.
h. Locking plate.
i. Trail plate bolt.
k. Trail plate.
l. Trail plate eye.
m. Chain eye bolt.
n. Locking chain.
o. Breast, or advancing chain.
p. Trail handles.
q. Handspike shoe.
r. Handspike pin.
s. Handspike ring.
t. Axletree arms.
u. Dragwashers.
v. Nave hoops.
w. Elevating screw.
x Handles of elevating screw.
y. Elevating screw box.

Statement showing the Weight and Dimensions of the various descriptions of Small Arms now in use in the British Service. (Enfield, 29th November, 1856.)

Description of Arm.	Barrel.					Bayonet.				Length of Gun.				Weight of Arm complete.		Charge.	Weight of bullet.	Remarks.
	Length.		Weight		Diam. of bore.	Length.		Weight		Without bayonet.		With bayonet.						
	ft.	in.	lbs.	oz	in.	ft.	in.	lbs.	oz.	ft.	in.	ft.	in.	lbs.	oz.	dms.	grs.	
Musket Line pattern, 1842, sighted and rifled -	3	3	4	14	·758	1	6	1	1	4	7	6	1	11	0	3	848	For Marines.
Musket Sea Service pattern, 1842, sighted and rifled - - -	2	6	4	2	·758	1	6	1	1	3	10	5	4	10	2	3	848	Naval Rifle for seamen.
Musket Rifle pattern, 1851 - - -	3	3	4	12	·702	1	6	1	1	4	7	6	1	10	12	2½	656	This Arm is entirely replaced by the 1853 pattern rifle.
Musket Rifle pattern, 1853	3	3	4	4	577	1	5½	0	12	4	7½	6	1	9	6	2½	530	
Short Rifle for Rifle Regiments, pattern, 1855 -	2	9	3	14	·577	1	11	1	9	4	1	6	0	9	12	2½	530	
Carbine Rifle, Artillery pattern, 1853 - -	2	0	3	1	·577	1	11	1	9	3	4	5	3	8	10	2	530	
Carbine Rifle, Sapper's pattern, 1853 - -	2	7½	3	7	·577	2	0	1	8	4	0	6	0	9	6	2½	530	

SHOT.

Canister shot are packed loosely in tin cases. Grape shot are tied together round an iron spike, on a wooden or metal tompion, and are thus said to be *quilted;* the number and weight of these balls being determined by the size of the guns for which they are intended.

These packages are stowed in wooden cases, which weigh about 25 pounds each, and average about 2 feet 4 inches in length, 1 foot in depth, and 1 foot in width.

Shrapnell shell is similar to the common ones, with a thinner crust of iron filled with leaden balls, and a small quantity of powder; and the fuse hole has a shoulder to receive the fuses made expressly for this projectile.

Number of balls in

6 pounder - - -	27
9 " - - -	41
12 " - - -	63
18 " - - -	120
24 " - - -	175
32 " - - -	225

GETTING IN GUNS.

For taking in or hoisting out 'tween-deck guns, no purchase that can be rigged is so quick, safe, and convenient as the davit, excepting the cat.

But the cat head is only available when it overlooks a port; the davit may be rigged anywhere, as is evident in the case of the waist anchors.

Whichever of these two methods be adopted, it must be observed that the longer the slings are, the less will the lower purchase block nip against the upper port sill. If the cat block be used, the hook should stand outwards, and whatever kind of purchase be used in working guns through ports, the port should be lined, and the port lid and sweep piece unshipped.

For 'tween-deck guns, a hole is cut through the plank of the

deck overhead in a line with the centre of the port, and something more than the length of the gun carriage from the side; through this the eye of the strop of a clump block is rove, which is toggled on the deck above, and wedged nearly close up.

The runner of a tackle is rove through a block on the other side of the deck looking straight into the clump, led through the clump and *clinched* into a good hook; this is the *gurnet.* Its duty is, when hoisting in guns, to hook on to the neck ring of the gun, and when the button is as high as the lower port sill to haul the breech inboard up to the beam of the deck overhead, whilst the carriage is placed under it.

The gun is slung on its upper side by a pair of rope slings; one bight of which goes over the neck, both parts being seized together, leaving an eye large enough to be easily thus placed; the other end is hauled taut along the gun, and a lashing is passed round slings and gun outside the trunnions; to this end the purchase hooks. The gun is hoisted muzzle upwards; the gurnet pulled up; the purchase let go, and if *nicely* lashed at the right spot, the trunnions fall right into the boxes; the cap squares are turned over, the forelocks put in and twisted.*

TO RIG A YARD PURCHASE—SAY, STARBOARD SIDE.

Brace the main yard so as to overlook a convenient port; line that port; unship the port lid and sweep piece, and then measure for the gurnet hole. Top the yard, hook the port yard tackle, or a rolling tackle, to a strop on the mast at the necklace, reeving the fall there, and sending it on deck. Put a long tackle on the starboard yard-arm from the cap, hooking it to a strop on the yard far enough out to plomb a lighter's hatchway. In small ships put a cross lashing on the bunt of the yard round the mast; haul taut all the gear, and have the heel of the boom well secured. It is not singular to shake the lee one off whilst hoisting in. Reeve a set of top tackle gear on the deck, running the top block down the pendant close to the upper top tackle block, and rack it there. If the yard is forward, send the starboard

* A ship in a gale, not many years since, pitched a forecastle gun through a port, in consequence of the forelocks having worked out.

main-top-sail buntline down abaft the main yard, and a double whip from the main lift put on in a line with the strop of the preventer lift. Trice the top block up with the whip, and the pendant with the buntline. Secure the pendant over the main cap, putting some mats between them. Lash the top block round the main yard alongside the strop of the preventer lift, and cut the racking. Put a whip on the lower block from the off side of the lighter to round the purchase down with, and work its fall on the deck of the ship. Lash a long tackle on the foremost pendant starboard side for the gurnet. If the top tackle fall is short, let down the pendant; and if the yard is small and the weight to be raised great, tail the fall and carry it through a leading block at the upper top block to the mast head, and thence to the deck.

Another way to rig the gun purchase is to arrange everything as before described, but omitting to lash the top block, and putting a runner and tackle on the yard for an outhauler; then lash the runner block at the yard arm, pass the runner over the main cap, rounding the tackle close up, and securing the runner round the mast head; make the lower block of the tackle fast to the top-block; haul out on the tackle until the purchase plombs the hold of the lighter; when the gun is up, ease in the tackle, and so on.

In hoisting guns out with this purchase, the purchase is eased in far enough to plomb the port; and when the gun is weighed, the runner tackle is hauled out far enough to admit of lowering it into the vessel alongside.

In most cases where this kind of purchase is made use of, there is more strain on the runner tackle than is quite safe; especially when the lighter is not an open one, and the purchase has to plomb her hatchway.

Heavy main deck guns, such as a frigate's, are far more easily and safely handled through the ports than the skids. In the latter way, the lifting purchase seldom, if ever, plombs the carriage; the gun binds; jiggers and hand spikes are required; and with a double strain on the gear it is dragged on or off the carriage both in coming in and going out, to say nothing of the additional ten feet hoist. Top tackle gear *may* stand this, but *a launch's* purchase is not equal to it. It lightens work very

much if the axles and insides of trucks are cleaned and greased before taking the guns in.

If there be delay about carriages, and time presses, lower the guns on the deck, putting trucks on the trunnions as they are being lowered.

In throwing guns over board when on shore, buoy them with the trucks and breechings.

A brig which was too small to admit of a derrick being rigged was thus quickly and efficiently fitted in raising the guns of the "Formidable." A spar was formed with two parts of the chain cable, clove hitched round each mast head, the after ends set up at the stern, and the foremost ones over the bows through the hawse holes. A top-gallant yard from the ship, being lashed fore and aft at the mast heads, assisted to prevent them from being drawn together. The purchase was lashed on the span, and worked over the side.

CHAP. XVI.

BOATS.

Boats are either *clinker*, *carvel*, or *diagonally* built.

Carvel and clinker are timbered; in the former the planking is smooth (flush). In the latter, the upper strakes overlap the lower. Diagonals are not timbered, but the planking is double, rising in opposite directions from the keel at an angle of about 45°.

Launches, *barges*, *pinnaces*, and *paddle box boats* are diagonal, and mostly made of mahogany.

Cutters, gigs, jolly boats, &c., are clinker, and of elm.

The value of launches is about 10*l.* less than 4 times their length in feet; the price in building about ⅓, and of materials about ⅔.

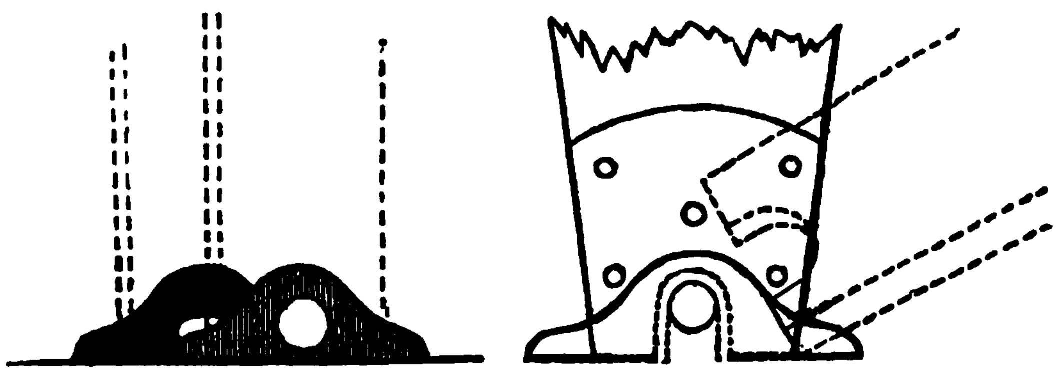
The value of barges and pinnaces is about 2½ times their length in feet.

The value of cutters, &c., about 1*l.* 1*s.* a foot.

A large repair costs about 1*l.* a foot in a launch. Barges somewhat less. They are fitted with chain slings for hoisting, and the ring in the centre of those of the quarter boats is usually altered on board to a *hook.*

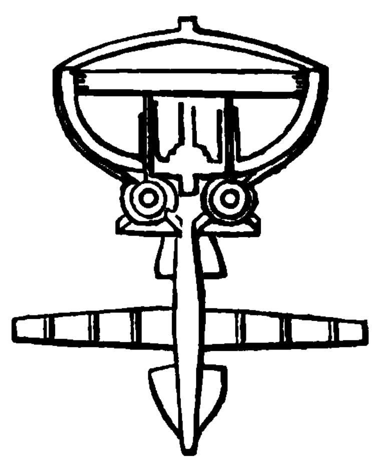
The plug holes should be fitted as a small leather-hinged hatch, opening downwards, and the rubbing pieces on the bilges made deep enough to be pierced with holes, so as to admit of a man's holding on by them when the boat upsets.

Fig. 178.



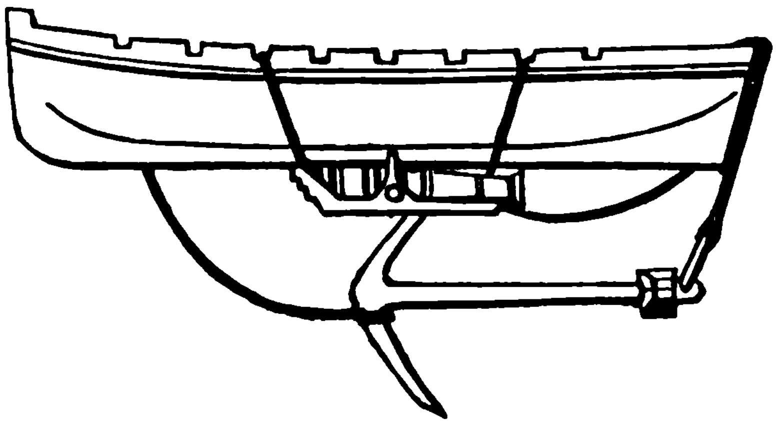
The mast steps are best made of two iron lugs, having a bolt rove through them, the heel of the mast being iron plated on each side, and scored out across the bottom, to the size of the bolt. When the heel is brought against the bolt, which is done by unshipping the next thwart, the mast is easily stept by a very few hands with the halyards led forward. (*Fig.* 178.)

Fig. 179.



Many of the large boats are fitted with pipes which step into holes in the bottom, directly under the windlass: these are made use of when it is required to carry such a weight under the boat as she could not bear at the stern. (*Figs.* 179, 180.)

Fig. 180.



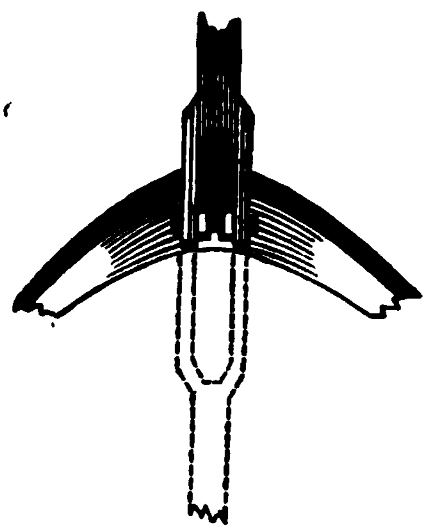
Weights and Tonnage of Boats by Builders' Measurements.

Boat.	Length.	Tonnage.	Weight.
	feet.		cwt.
Launch - -	42	18	5 0 0
Pinnace Launch -	42	14	4 2 3
" " -	38	- -	3 6 3
" " -	36	12	3 4 0
" " -	34	- -	2 14 2
Barge - - -	35	- -	1 14 0
" - - -	32	- -	1 11 0
Pinnace - -	32	7	1 11 0
" - - -	30	5½	1 8 0
" - - -	28	- -	1 5 2
Cutter - - -	30	- -	0 18 0
" - - -	28	- -	0 16 0
" - - -	25	3½	0 11 2
" - - -	23	- -	0 10 2
Gig - - -	32	- -	0 8 3
" - - -	28	- -	0 6 3
Cutter - - -	20	- -	0 8 2
Jolly - - -	18	- -	0 7 1
" - - -	16	- -	0 6 0
Dingy - - -	14	- -	0 4 2
" - - -	12	- -	0 3 1
Gig - - -	22	- -	0 5 0

Coppering of a 42-foot Pinnace Launch.

Height of coppering 3 ft. 4 in. aft, 3 ft. 1 in. forward.
Bottom, 78 16-oz. sheets ; 30 lb. nails.
Keel, 8 28-oz. sheets ; 8 lb. nails.
Weight of boat thus, 4 tons 16·1 cwt.

Fig. 181.



The iron bowsprits which are fitted to boom boats, are only intended for use when the gun is mounted ; and should invariably be unshipped before going alongside. The least collision will materially injure the stem.

Unless fitted so as to pivot in lugs on the breast hook, they are most difficult to ship in a sea way, and the attempt is frequently attended with loss. Pin the heel first, and turn the point over with the jib halyards.

For general purposes, wooden bowsprits are found to be a great means of saving repairs. With these provisions for the stem, and the shoeing on the heel of the mast, the equipment of boom boats is perfection.

In fitting gun slides for boats, if the hole through which the bolt that connects the slide with the thwart reeves be made oblong instead of circular, the gun may be lowered without being dismounted. Run the gun forward (say bow gun) : a few hands can support the after end of the slide; whilst the thwarts are unshipped, lower that end of the slide, and let the gun run down. To raise the gun ; run it up, raise the after end of the slide, and ship the thwarts.

HOISTING IN AND STOWING BOOM BOATS.

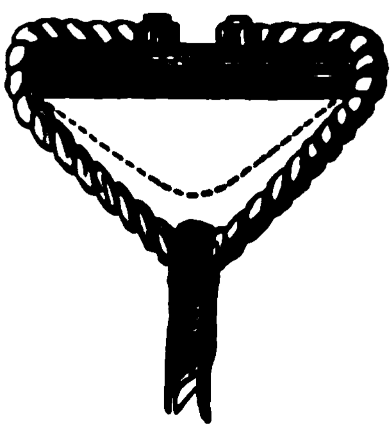
The large screw ships have two launches, which must be stowed abreast, and well aft, clear of the funnel. In this case the booms, *i. e.* the spare topmasts, hand masts, fish pieces, &c., are stowed on each side, as close as may be safe to the funnel casing, and the crutches secured to the deck outside of them. The top-sail yards lie under the boat outside these crutches.

The main-stay "looking" so much up and down requires no span; its pendant is run up through the fore part of lubbers' hole, and hooked round the heel of the top-mast to its own part, or to the main-yard slings.

The fore-stay pendant hooks to a strop underneath the after part of the fore-top, and is guyed aft to the main-top by a span, so as to plomb the place where the bow of the boat is to be stowed. The longer this pendant is, or, in other words, the longer the span, the better; and *every inch* is of value.

In the course of a series of experiments made under the direction of Mr. Tinmouth, with the view of ascertaining the properties of spans, the ropes were arranged with different lengths of bight, as in the *fig.* 182. It was found that whilst rope of a certain size broke with a strain of 7 tons when at an angle of 31½°, the same sized rope carried away with a strain of 6¼ tons when at an angle of 29½°. From these and similar results he concludes that where a span is so placed as to have a less angle than 30°, the strength of the two parts of rope or chain of which it is composed, is less than the strength which one such part would have, if placed in a direct line with the strain.

Fig. 182.



Span.

This reasoning applies not only to spans such as are used in hoisting in boom boats, but also to slings of all kinds, and especially to the important subject of mooring. As applied to the latter, the properties of the span have already been scientifically discussed, "and may be practically shown by stretching a small line between two points, and suspending a weight in the middle; ascertaining what weight it will bear, and afterwards trying what the same line will bear vertically. The latter will be the ship at anchor; the former the one moored." *

The runners and tackles are used for hoisting in heavy boats; but as the runner is inconveniently long, it is usual to reeve some spare rope as a launch's purchase. This is arranged in much the same way. A double block is spliced into a pendant,

* Heaving down the "Melville." Captain Harris, R.N.

and the fall is rove through another double block; or else it is rove through a double and single, according to choice. The pendant is rove through either a smooth round thimble or a clump block, which serves the purpose of a lizard in guying the purchase out to the lower yard-arm. These are fitted with strop and toggle, or with double tails. The end of the pendant is spliced into a hook and thimble, and when triced up is passed over the cap and hooked to its own part. Lower reef tackles when tailed are very useful for tricing up runner tackles, and we have already said that top-sail buntlines answer well for pendants. Heavy launches have four ring bolts at each end; and it is sometimes thought advisable to use not only the runners and stays, but also the yard and long tackles, distributing these tackles among the several ring bolts. It may be allowable to remark that there is a practical difficulty in keeping an equal strain on all, and that if the large tackles carried away, the small ones would not support the weight. However, it is certainly well, when there is much scending motion, to carry the main-yard tackle forward, and the fore one aft in the boat; and in rolling to have stout slip ropes through the ports. Merely tossing a boat out or in, during fine or previous to bad weather, is such a trifling operation, that it seems unaccountable why boats should be left in the water for any considerable period, especially at night; but it becomes a grave affair when a heavy launch is scending in a sea way from under the main-yard to the fore; and too many precautions can scarcely be taken.

In securing the tails of lizards, they should be passed twice round the yard-arm, but not round the pendant. If a whip is used for tricing up, see that the end of the bend is so short that it will not get into the block. Place the yards. In large ships spread is a greater consideration than topping: in small ships it is necessary to top them. Put on preventer lifts or top burtons, and when the trusses and lee rolling or yard tackles are taut, pull all the lifts and top-sail sheets taut. Back the fore-yard up with a tackle or two parts of a hawser from the bowsprit cap to the yard-arm; and when it is fast, check the opposite fore brace. Boom jiggers, especially the fore ones, are frequently forgotten in bracing yards in; and before the yards are secured, they should be so free from restraints as to look to their work in a straight line.

Fig. 183.

Foul hook.

In hooking on in the boat, see the turns out of the tackles; and in hooking on the stays aloft, remember that launches have come down in consequence of the stay having been hooked with a kink, although the hooks were of faultless construction and proportion. (*Fig.* 183.)

Put luffs on the off side anchor stock and main rigging for hauling the boat over with. If there is a choice, put the short leg of the fore slings forward. The objection to short spans with rope applies also to chain; and slings may be lengthened with some stream chain shackles. Four hands will be sufficient in the boat, after she is baled out and prepared for hoisting.

Lead the falls so that the men will never be under the boat when she is over the deck. Have leading men to pass lizards, connect ends of purchases, stopper, and belay; as well as seconds to the belaying men, whose duty will be to "light to," whilst taking the turn, and pay the fall clear in lowering. Working on an upper deck, it answers well in coming in to put the men belonging to the fore part of the ship on the main-yard, and those belonging to the after part on the fore-yard, as, when the yards are high enough, all hands will be on their own stations ready for stays or other duty.

Run the *slack* of the stays in as the boat rises, yet without bending her to the side. When there is much slack left to run away with, the chances are in favour of a bight getting well into the swallow of the lower block before the men can be stopped; the boat will then be carried in by one part of rope, and a heavy surge is then *inevitable.* The men in the boat must be warned to sit tight, and *then* the stays let go. The higher the yards are hoisted, the greater will be the strain on the fore-yard. Commence easing in the fore-yard as soon as the fore-stay is bearing weight. When the keel is high enough to clear the crutches, haul over with the off guys. If the boat is required to go forward, slack the main-stay; if aft, the fore-stay. If there are two launches, hoist the off side one in first; don't wait for a few inches as to fore and aft line; go on with the other, and complete the duty afterwards with the stays. In hoisting out, take the nearest launch first, for reasons mentioned above. The purchase *should* be triced up and unhooked the instant it has

done its duty, without waiting for stays, and the men who are stationed at the lizards should remain in the futtocks ready to inspect or disconnect their gear. If braces and tackles are satisfactorily arranged, put bracing in and hoisting marks on the gear, remembering that the higher the boat is hoisted, not only is there more time occupied, but the fore-yard is more strained. The officer carrying on forward is too frequently changed in his station to be enabled to tell by the eye; but a boatswain of the genuine kind will pride himself on grazing the waist nettings.

When hoisting out in a tide or sea way, have a boat-rope passed from forward led outside all, and bent to the boat before she touches the water.

Yard tackle pendants become very much injured in the splice of the eye by wet, and the falls by chafe when kept aloft; besides being no handier than when kept on deck with a whip on the yard for their use. If kept on deck, fit the end with a thimble and hook, and have a strop made of two parts of rope marled together in the thimble, with a thimble in its bight large enough to take the hook. Make this strop long enough to go round the yard, bend the yard whip two feet down the pendant, and stop the strop up on the whip.

Top burtons are usually used for preventer lifts, and are difficult to carry out to the lower yard-arms, especially when topped much. A spare lift, formed of a piece of thick rope having a hook and strop with a thimble at each end, has been found to answer well. This is kept middled over the lower cap. When required, one end is hauled out to the yard-arm by a small line, the strop passed round the arm and hooked, whilst the other end is set up with a lanyard in the top. If the topmen neglect making it very taut, the standing lift may be checked as the tackles are hauled taut.

Snatches on the lower yard-arms are convenient for scoring top-mast stud halyards in for yard-whips. Keep a hank on the halyard with a line fast to it. Carry the line out to yard-arm; after cutting the stop of the halyards, haul out and score them; the end of the halyard being on deck, is all ready for bending on.

Barges and pinnaces are hoisted in with the yard tackles and *stays alone*; and, bearing in mind how frequent is this operation *and the* constant exposure of this gear, every opportunity for

examining the eye at the yard-arm, and the state of the falls and blocks, should be taken.

In very large sailing ships the barge and pinnace are stowed on each bow of the launch ; but in others all three are abreast, and so crowd the gangways that it is necessary to work many ropes on the main-deck. They may be fitted thus : —

Put the launch in her place ; stow the booms. Support her by curved crutches, the heels of which work in pairs of lugs on the skid-beams, and the tops in clamps which fit on the rubbing-streak ; these clamps have lugs between which the point of the crutch enters, and is secured there by a pin through all parts; thus the clamp pivots, and the crutch pivots. Have three of these crutches on each side of the boat, and let them be long enough to bear taut against her ; fit all the thwarts of the launch and barge to unship ; fit the stern gratings to ship on ledges fastened fore and aft, about eight inches apart. Let this vacancy be filled by a board when the boat is in use ; the gratings are fixtures.

Put the barge inside the launch ; her keel will enter between the grating ledges. Put chocks between the outside of the barge and inside of the launch in the wake of the crutches. Put the pinnace inside the barge, and in like manner her keel will stand all along on the barge's keelson.

In making these arrangements, take care that the thwarts are not turned with the points of their finger bolts downwards ; and lay the oars on each side on the bight of a piece of rope from the gunnel ; so that when the inside boat is out, they may be parbuckled up to the gunnel whilst the thwarts are being shipped.

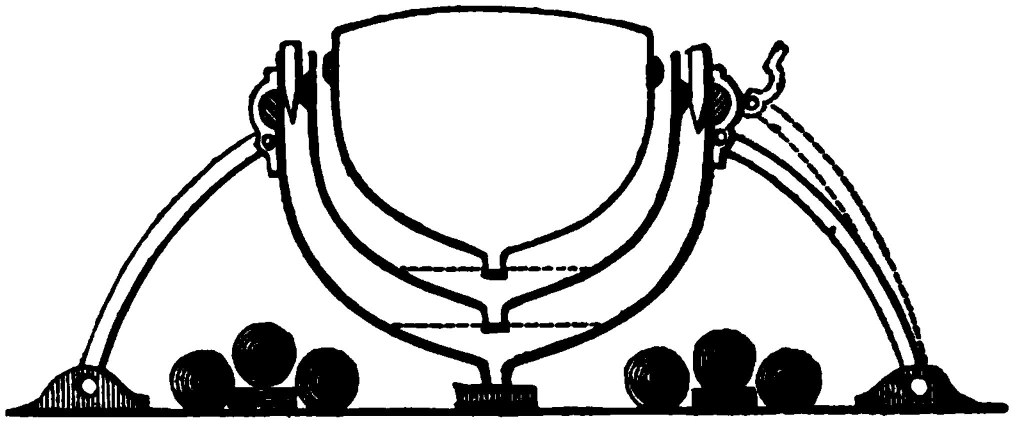
In hoisting the launch in, the crutches are held nearly upright ; and the clamps being turned back, their inside ends catch her side whilst being lowered, and drop into their place.

The crushing power and consequent security of these crutches may easily be shown by starting the chocks on which the keel rests: when borne by them alone, her sides would be actually stove in.

These fitments were first adopted in the "Thetis," and then carried out in the "Phaeton," and "Arethusa;" and when it was demonstrated that the boats preserved their shape, could be manned and armed from the booms without delay, that the gangways admitted of working three guns brought from an unengaged side, that the *spars* were always come-at-able, that the boats

were less in the way in their place on the booms than in the water, and that the rain awning could be spread at sea as well as in harbour, besides affording at quarters a very commanding position for small-arm men,— were greatly approved of.

Fig. 184.



Boom boats stowed in one.

Launch, 36 feet; Barge, 32 feet; Pinnace, 30 feet.

	ft.	in.
Launch above deck - - - -	6	6
Gunwale of Barge above Launch - -	0	8
Pinnance above Barge - - -	1	2
Extreme height - - - -	8	6

Deck clear of skids on each side, 8 ft. 10 in.

The dotted line shows the position of the crutch when hoisting the launch in.

CHAP. XVII.

SAILS.

All canvass used in the navy is flaxen, made in cloths of 40 yards in length, and in breadths of 2 feet and 18 inches. These cloths are rolled up in separate packages, called bolts. The *stoutest* being No. 1, from which the canvass increases in fineness, *and diminishes* in strength to No. 8.

Sails derive their name from the mast, yard, or stay, upon which they are set: and excepting the jibs and spanker are made up of 2 feet wide canvass.

In all square sails, the upper part is called the *head*; the lower the *foot*, the sides the *leeches*, the lower corners, the *clues*; and the upper corners, the *earings*.

In fore and aft sails, such as the spanker, boom main sail, trysail, the upper inner corner is called the *nock*, the outer the *peek*, the lower inner corner the *tack*, and the outer one, the *clue* or *sheet*. In such as jibs, the upper corner is the *head*, the outer the *tack*, and the inner the *sheet*.

The cloths are sewn with *sail twine*, the seams being double: those of courses, topsails, lower stay sails, trysails, and spanker are 1½ inch wide, and *stuck* (treble seamed down the middle of the seam); those of other sails are 1 inch wide. There are about 140 stitches to each yard; and one man can sew 100 yards in 9½ hours single seam.

The foot of a course is *roached*, so as to clear the deck; and in all sails, those cloths which are cut in any other direction than straight across with the thread (or woof), are said to be *gored*.

No. of Canvass.	Weight of Bolt in Pounds.	Price per Yard.	What generally used for.
		s. *d.*	
1	44	0 10½	Courses; Stay Sails.
2	41	0 10	Topsails.
3	38	0 9½	Mizen topsail.
4	35	0 8¾	Second Jib; Spanker.
5	32	0 8¼	Jib, top lining; T.Gt. Sails.
6	29	0 7½	Studding Sails.
7	24	0 7	Royals; T.Gt. Stud Sails.
8	21	0 6¼	Flying jib.

Sails are supplied ready made, only requiring fitting with points, earings, bowline bridles, beckets, robands. Their edges are *tabled*, and stitched to the *bolt* rope. The tabling of large

sails is strengthened at the clues and foot by a third fold of canvass sewn in it. Small eyelet holes are worked through the tabling; and canvass and rope are then *marled* together. The roping of the clue is stoutest; tapering off to the leech rope. The foot rope is wormed, parcelled, and served.

In square sails the rope is always sewn on the after side; in fore and aft sails on the port side.

The sails are strengthened with additional canvass at those places most exposed to strain and wear: in square ones, in the wake of cringles along the leeches on the foreside, called *lining;* in the wake of buntlines on foreside, called *buntline cloths;* across the foreside, called *reef* and *belly bands;* and in the case of topsails, on the afterside, called the *top linings.* Fore and aft sails are strengthened at the clues by *tack pieces;* and jibs sometimes with a *strain band.*

The *eyelet holes* are all bound by a grummet: those for robands and points are placed alternately two and one in the head, and two upper reefs; the third and fourth reefs have two in each cloth.

The *clues* of courses are formed with a stouter piece of rope than the foot rope or leech; its ends being tapered and spliced into them about four feet above the clue.

The *foot rope* of topsails is carried round the clue, and tapered into the leech rope in like manner.

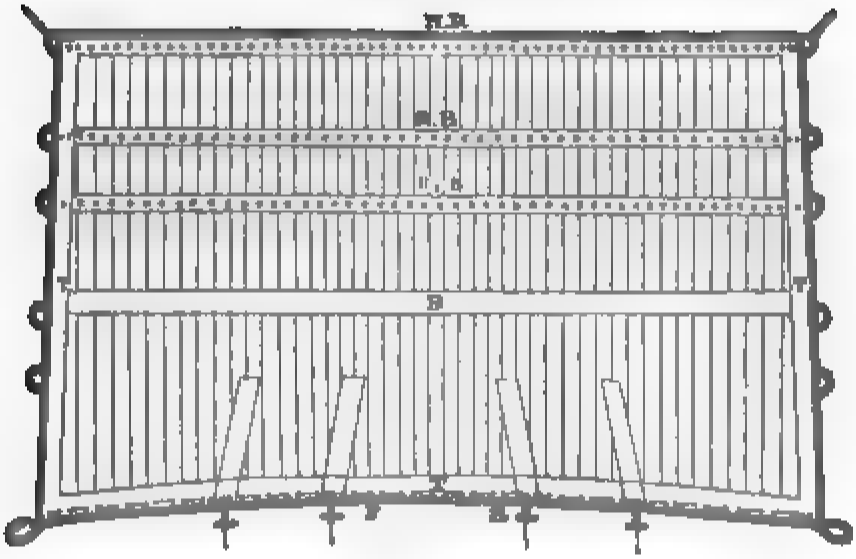
The clue thimbles are seized in; those of the earings, reef tackles, bowlines, &c., are fastened with bolt rope strands; which are worked round the leech rope through eyelet holes in the tabling.

Courses have two reef bands on the foreside; each being $\frac{1}{6}$ the depth of the sail in the middle from the head; with a belly band half way between the lower reef and foot. (*Fig.* 185.)

Topsails have four reef bands, on foreside, the lower of which is at half the depth of the sail; the belly band, also on the foreside, is half way between the lower reef and the foot. All top-gallant sails have three bowline cringles; the foot rope is spliced between the two lower ones, and is served and marled a short distance in leech and foot. (*Fig.* 186.)

... seems to be impossible that, consistent with convenience ... he spars of ships should be different in form from ... Had masts a great rake, the loss of a ... ugh to set a sufficiency

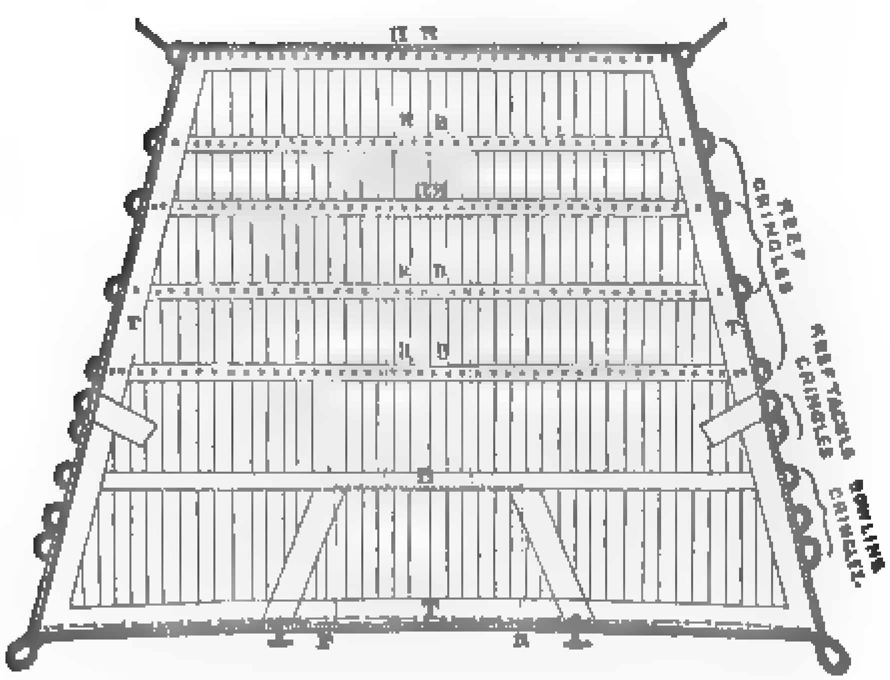
Fig. 185.



Fore side of Course.

H R. Head rope. B Belly band.
T. Tabling. R B. Reef bands.
B R. Buntline Toggles.

Fig. 186.



Fore side of Topsail.

of fore and aft sails, the ship could never be relieved of top weight, and the sails would be unmanageably large. At all events the sail maker has to cut to given measures, and to adapt his sail to any attitude in which the mast may be placed.

Were a sail to be exactly square, there would be little art in cutting ; but as a ship's sails are, mostly, anything but square there is much skill required in the arrangement of every cloth. In cutting out, and making them up, it is a primary object to adapt and cut the numerous gores which, when brought together, will produce the ultimate form required, with the least possible waste of canvass ; and this has been obtained by the long study and practical experience of the master sail makers in Her Majesty's dockyards, as the waste canvass in cutting out a large suit is trifling. This is effected by their method of casting the number of inches contained in each gore, so that when they are brought together they shall be equal to the number contained in the after leech cloth ; this is in reference to fore and aft sails, but the same theory applies in the parts of square sails.

The bolt rope sewn on the hollow or straight leeches of square sails (or marled on their foot), is put on with sufficiency of slack canvass to admit of that stretch of rope which arises from the action of the wind, or the constant strain or pull upon the margin of such sails; and the necessary allowance for the stretch of the whole is made in the calculation of dimensions of such sails. But in the leeches of fore and aft sails, as also in the round foot of spankers, jibs, &c. &c., a sufficient quantity of slack rope is introduced to keep the foot from curling up to leave the after leech of these sails free, and also to compensate for the amount of stretch those parts of the sails above named are constantly liable to.

Spankers are made with an allowance to stretch of 3½ inches in each 3 feet of the foot, 1½ in each 3 feet of the head, and 2½ in each 3 feet of the length of the leech.

Sails are always bent to their yard or gaff with the roping next the spar, otherwise the stitches would be cut through by friction.

In the sails, in *figs.* 187. and 188., there are three gores in each ; and pulled as they are at one corner, it will be most difficult to bring an equal strain on every part of each cloth, and thus make them stand well. Now, where there is no necessary

Fig. 187.

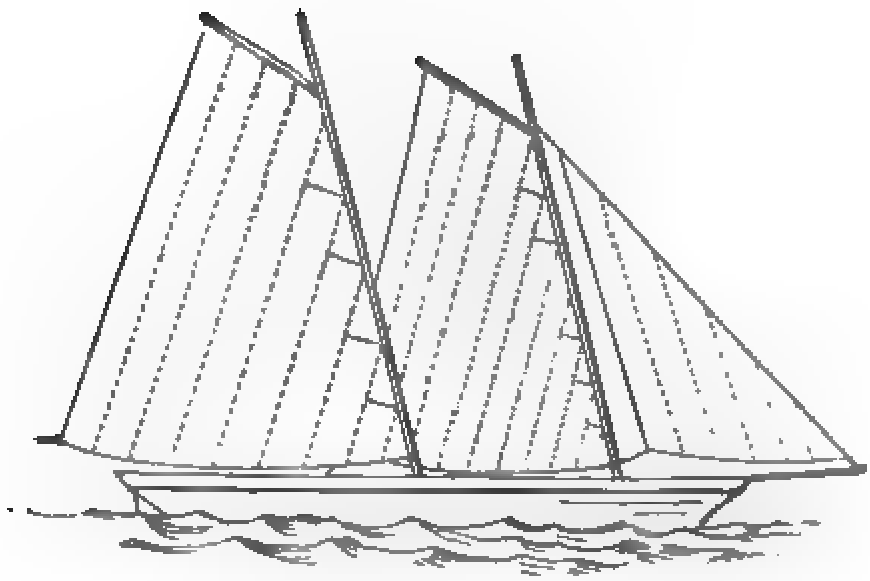
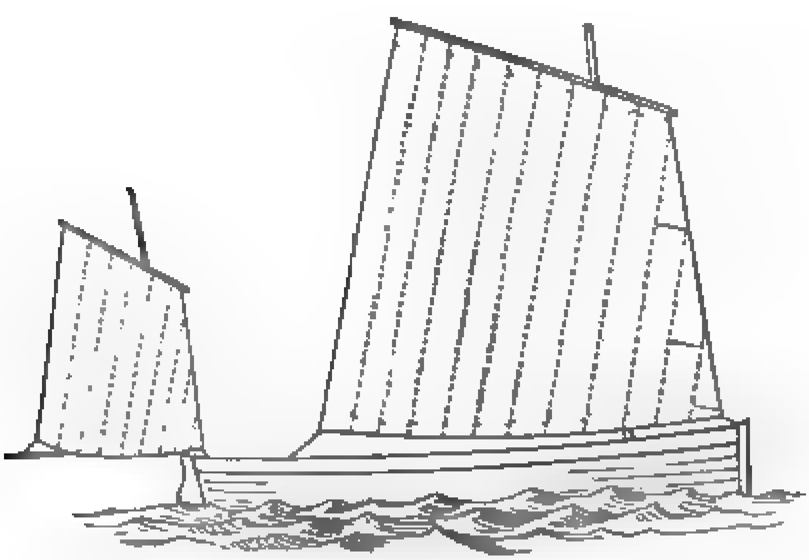


Fig. 188.

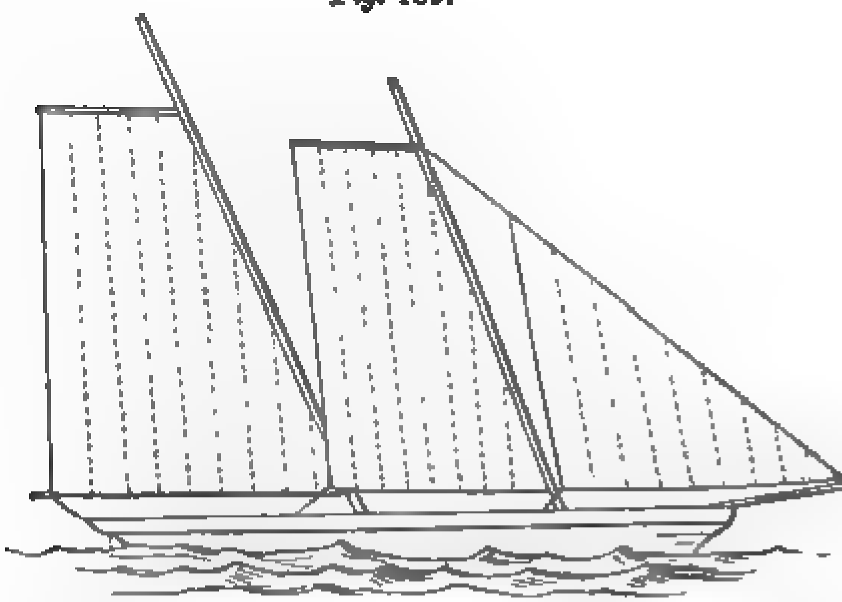


restriction as to form (as in the case of yachts), we may throw the same amount of canvass into such a shape as will, to a great extent, dispense with goring, and so dispose of such as may be absolutely needful as to render it harmless.

The whole novelty and nearly all the efficiency of the "America's" sails were owing to their goreless shape, the canvass being cut as much as possible on the thread or woof,—that is, at *right angles to* the warp; and then to the adoption of the

system common in the South Sea boats of lacing the sails taut to the spars.

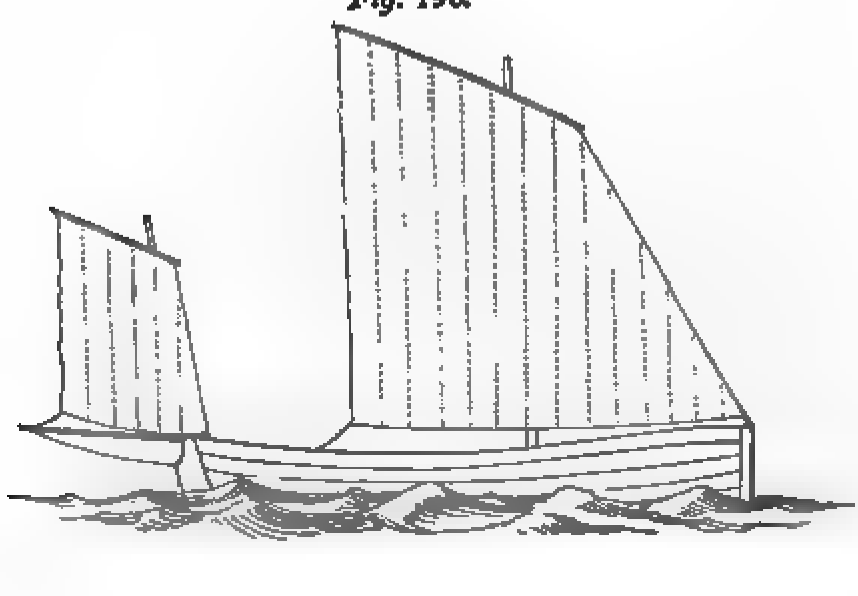
Fig. 189.



In *fig.* 189., each cloth is pulled bodily downwards, and every single thread in the web is stretched; and when properly set, such sails will rattle, on being tapped on, like a canvass bed bottom. The only gore is at the mast, to which, being unyielding, it may be tautened to liking with a lacing.

Such sails, however, require unusually strong gear: the masts, having great rake, must be very stout; the stays, partners, gaffs,

Fig. 190.



peek halyards, of large proportions. The thicker the canvass the better; and if of cotton, this advantage will be gained without increase of weight.

The cutter's sails, *fig.* 190., are on the same principle, and are evidently rising ones.

34-*foot Pinnace.—Fig.* 191.

Sails.	Cloths in Head.	Cloths in Foot.	Yards in Luff	Yards in Leach.	Total Yards.
Fore -	$6\frac{1}{2}$	8	$5\frac{3}{4}$	$8\frac{3}{4}$	62
Mizen -	$5\frac{1}{4}$	$7\frac{1}{2}$	$4\frac{5}{6}$	$6\frac{3}{4}$	44
Jib -	$\frac{1}{8}$	8	$5\frac{1}{2}$	$7\frac{2}{3}$	29

36-*foot Launch.—Fig.* 192.

Sails.	Cloths in Head.	Cloths in Foot.	Yards in Luff.	Yards in Leach.	Total Yards.
Fore -	$6\frac{3}{4}$	$8\frac{1}{2}$	6	$8\frac{5}{6}$	$69\frac{1}{2}$
Mizen -	$5\frac{1}{2}$	8	5	$7\frac{1}{6}$	47
Jib -	$\frac{1}{8}$	$8\frac{1}{2}$	6	$8\frac{1}{3}$	31

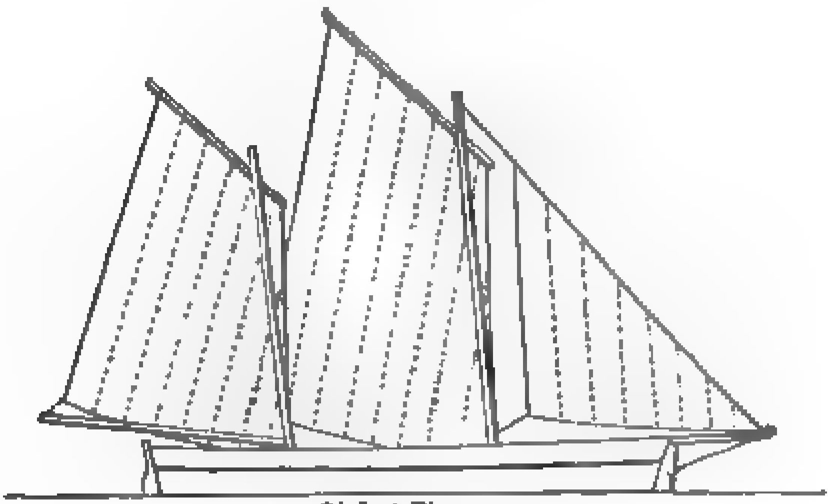
40-*foot Launch.—Fig.* 193.

Sails.	Cloths in Head.	Cloths in Foot.	Yards in Luff.	Yards in Leach.	Total Yards.
Fore -	$7\frac{3}{4}$	10	$7\frac{1}{3}$	$10\frac{2}{3}$	91
Mizen -	6	9	$5\frac{2}{3}$	8	56
Jib -	$\frac{1}{8}$	9	7	9	36

42-foot Launch.—Fig. 194.

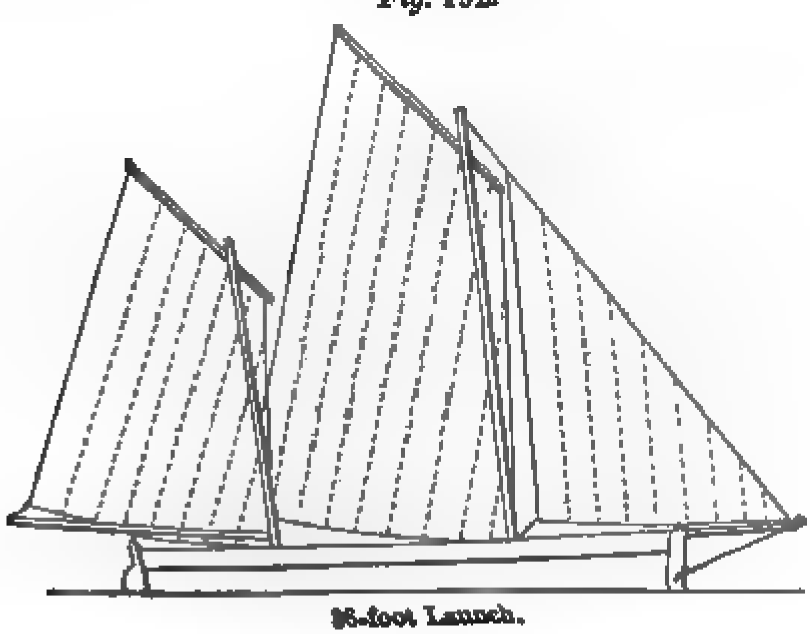
Sails.	Cloths in Head.	Cloths in Foot.	Yards in Luff.	Yards in Leach.	Total Yards.
Fore -	$8\frac{1}{2}$	$10\frac{1}{2}$	$8\frac{1}{2}$	$12\frac{1}{2}$	107
Mizen -	$6\frac{1}{4}$	9	$6\frac{1}{2}$	$8\frac{1}{2}$	$60\frac{1}{2}$
Jib -	$\frac{1}{2}$	9	8	9	$39\frac{1}{2}$

Fig. 191.



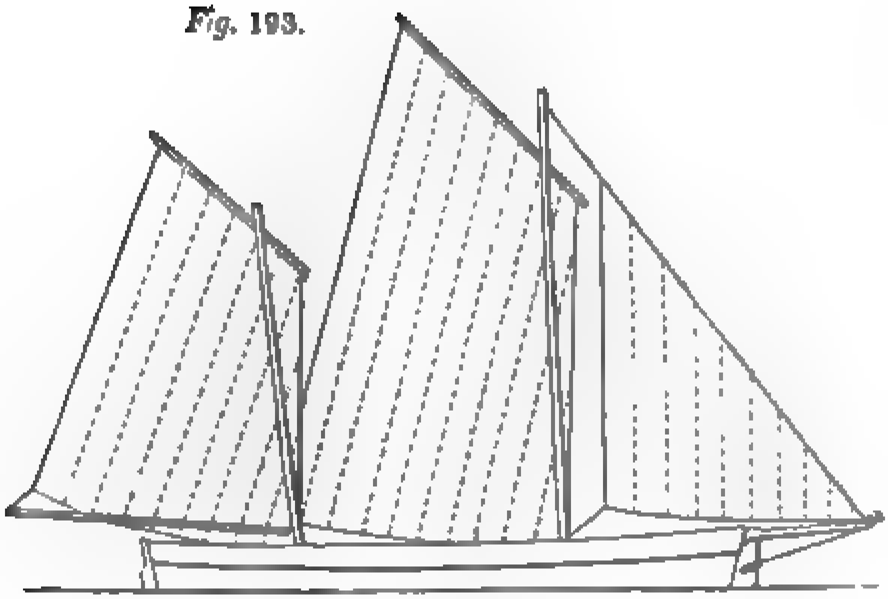
34-foot Pinnace.

Fig. 192.



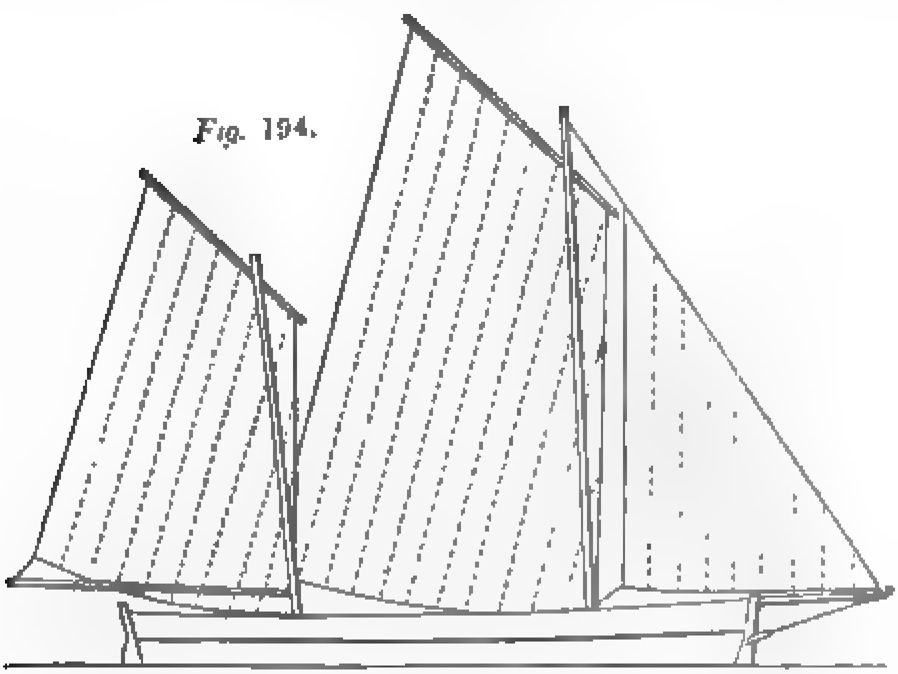
36-foot Launch.

Fig. 193.



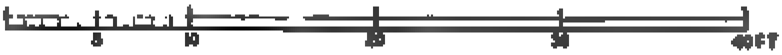
40-foot Launch.

Fig. 194.



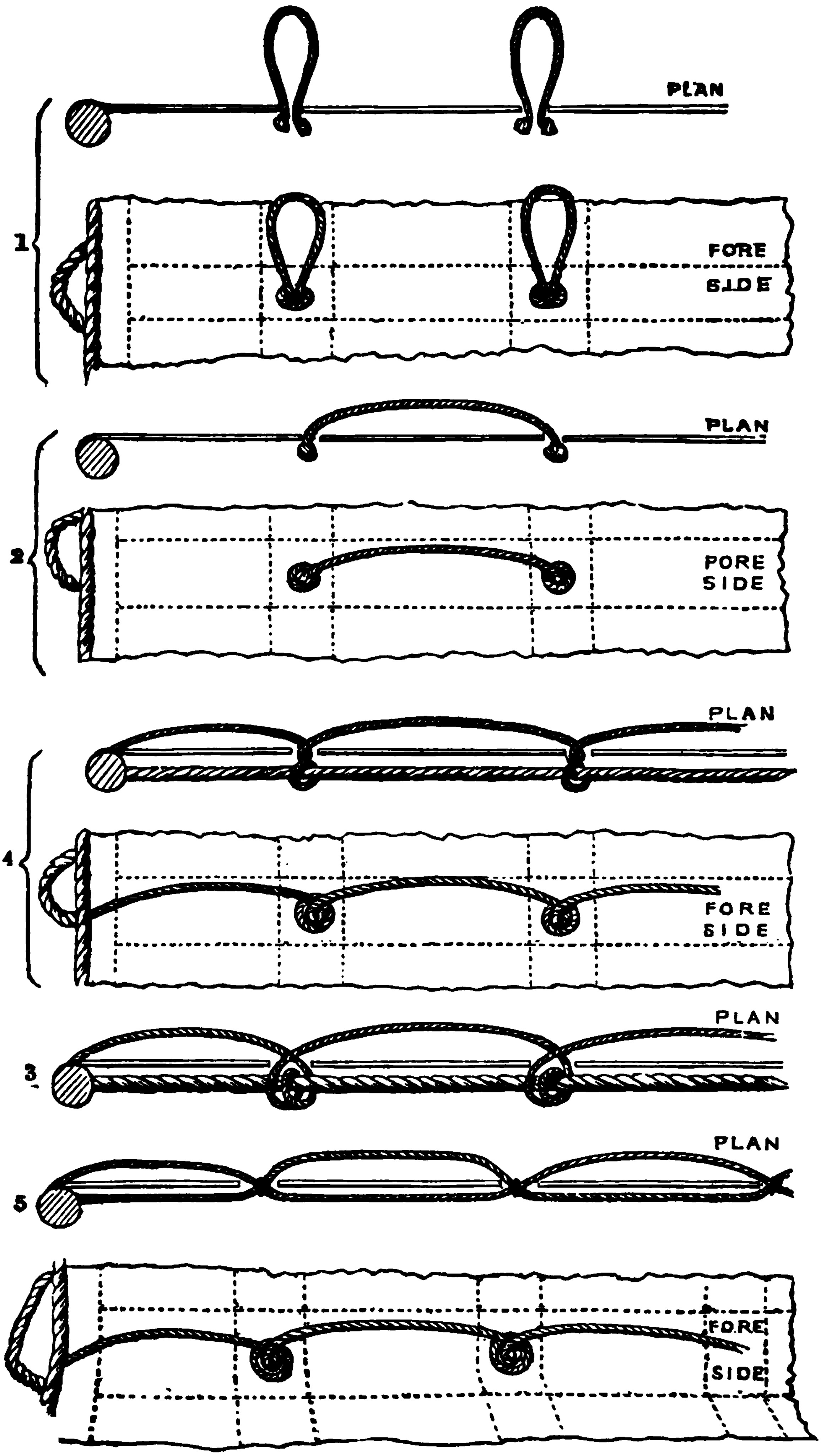
42-foot Launch.

The sketches of vessels of this and preceding pages are drawn to the following scale:—



The figs. 191, 192, 193, 194. are drawings on a scale of the beautiful sails that are supplied for service, and which always *stand well, when* properly set.

Fig. 195.


1
PLAN
FORE
SIDE
2
PLAN
PORE
SIDE
4
PLAN
FORE
SIDE
3
PLAN
5
PLAN
FORE
SIDE

Sails are pointed by putting the ends of the pairs of points, from opposite sides of the sail, through the eyelet holes, reeving the ends through each other's eyes, and hardening them together with sheaves.

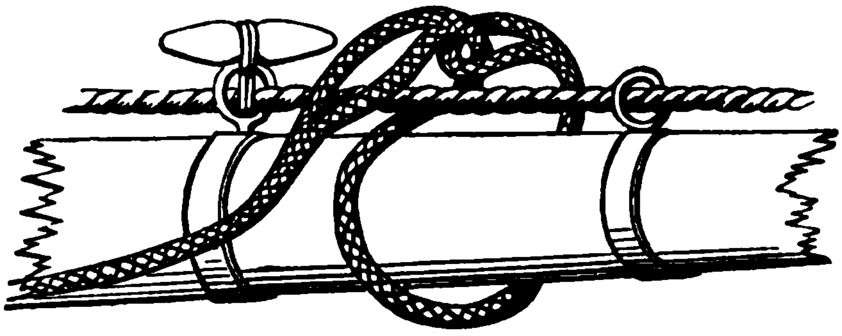
Many sails have latterly been fitted with beckets in lieu of points, the points being secured to the yard. These beckets are differently formed. (*Fig.* 195.) One way is to put both ends into the same hole from the fore side, knotting them on the after. Points jamb in these. Another way is to form the loop wider, by making it reach from hole to hole, knotting as before. This mode wrinkles the reef band, and prevents it from being hauled out taut.

A third plan is to have a line fast from cringle to cringle across the after part of the reef bands, and to form the beckets on the fore side with another line, one end of which is made fast to the cringle ; the other is rove through the first eyelet hole, passed twice round the after line, out again, and so on across the fore part, and made fast to the opposite cringle. On the same principle, some put the bights of the foremost lines through the holes with a hard kink, reeving the after line through the kink. This is more quickly done, and nips harder.

A fifth plan is to weave the two lines different ways right across, in and out of the holes, stitching the crossings. Either of these three last answers well: a great objection to the two first is that there is nothing to lay hold of abaft the sail. The great advantage of beckets is that the sails sheet home without fouling, as do reef points.

The points are made split far enough down to admit of being toggled. They and the toggles are generally secured to the jack-stay ; but if the jackstay carried away, and the earings held on, the yard would most probably go on top in the slings. For this reason, it is best to make the points long enough to go round

Fig. 196.



Jack-stay and reef point.

the yard, reeving through their own eye underneath and abaft the jack-stay. (See *fig.* 196.) In some ships two jack-stays are fitted with a view of keeping the reefs more distinct.

A comparison of weights between reef points and beckets is greatly in favour of the latter. Thus, in a suit of sails for a first rate, the weight of points would be about 10 cwt., whereas the beckets and their appurtenances, for a similar suit, would not exceed 4½.

The Number of Yards and Size of Canvass required for certain Sails for First Class Ships of different rates.

Sails.	120	120	80	74	50	46	36	26	18	First Class Brig.	Second Class Brig.
No.											
Flying Jib - -	7 230	7 230	7 230	7 210	7 210	7 188	7 148	8 110	7 130	8 110	8 92
Jib - - - -	5 460	5 470	5 460	5 382	5 355	5 330	6 262	6 200	6 210	6 200	6 [illegible]
Fore Course - -	1 938	1 770	1 850	1 674	1 720	1 630	1 463	2 369	2 375	2 369	2 294
Fore-top Sail -	2 926	2 796	2 796	3 664	3 614	2 667	3 436	4 316	4 347	4 316	4 298
" lining -	66	54	54	46	46	43	34	24	28	24	22
Fore-top-gallant Sail	5 289	5 254	5 254	6 212	6 195	6 177	7 141	7 102	7 109	7 109	7 92
Fore Royal - -	7 130	7 114	7 114	7 97	7 90	7 84	7 66	8 50	8 52	8 50	8 46
Main Sail - - -	1 1003	1 1012	1 1090	1 892	1 918	1 805	1 590	2 469	2 524	2 524	2 451
Top Sail - - -	2 1022	2 1017	2 1017	2 848	2 796	2 728	2 557	3 406	3 436	3 406	3 372
" lining -	76	73	73	62	54	52	43	30	34	30	28
Top-gallant Sail -	5 334	5 324	5 324	5 274	5 254	6 230	6 177	7 127	7 141	7 127	7 120
Royal - - -	7 144	7 144	7 144	7 124	7 114	7 106	7 84	7 60	7 65	7 60	7 56
Mizen-top Sail - -	3 520	3 520	3 520	3 436	3 406	3 372	4 316	5 227	4 250		
" lining	38	38	38	34	30	28	24	18	20		
Top-gallant Sail -	6 164	6 164	6 164	7 141	7 127	7 120	7 102	7 73	7 77		
Royal - - -	7 78	7 78	7 78	7 66	7 60	7 56	8 50	8 37	8 40		
Spanker - - -	4 535	4 580	4 590	4 530	4 670	4 500	4 380	4 280	4 310	1 460	1 450

'ace the formation of this table, spankers, jibs, and flying re made of 18-inch canvass.

A Table showing the Purposes for which the Classes are suitable.

	3 Deck Ships.			2 Deck Ships.				Frigates.										Corvettes.			Brigs.			
Classes	1	2	3	1	2	3	4	1	2	3	4	5	6	7	8	9	10	1	2	3	1	2	3	4
1	mn	...	...	mn																				
2	...	mn		...	mn																			
3		...	mn	...	...	mn																		
4	fore	...	...	fore	...	...	mn	mn																
5	...	fore	...	...	fore	...	...	...	mn															
6	...	...	fore	...	...	fore	...	...	...	mn														
7	...	...	...	...	...	...	fore	fore	...	...	mn													
8	...	...	...	...	...	...	...	...	fore	...	...	mn												
9	mis	...	...	mis	...	...	...	...	...	fore	...	...	mn											
10	...	mis	...	...	mis	...	...	...	...	...	fore	...	...	mn										
11	...	...	mis	...	...	mis	...	...	...	...	...	fore	...	...	mn	...	...	mn						
12		...	...	...	...	...	mis	mis	...	...	...	...	fore	...	...	mn	...	...	mn	...	mn			
13	...	...	...	...	...	...	...	...	mis	...	...	...	...	fore	...	...	mn	...	...	mn	...	mn		
14	...	...	...	...	...	...		...	...	mis	mis	...	...	...	fore	...	...	fore	...	...	...	...	mn	
15	...	...	...	...	...	...	...	...	...	...	...	mis	...	...	...	fore	...	...	fore	...	fore	...	...	mn
16	...	...		...	...	...	...	...	...	...	...	...	mis	...	...	...	fore	...	...	fore	...	fore	fore	
17	...	...	...	...	...	...	...	...	...	...	...	...	...	mis										
18	...	fore	...	...	...	...	...	...	...	...	...	...	...	...	mis	...	...	mis	...	...	...	...	...	fore
19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	mis	...	...	mis					
20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	mis	...	...	mis				

Weight of Sails.

	Flying Jib.			Jib.			Fore Course.			Top.			Top-gallant.		
	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
Vanguard, Rodney, St. Vincent, &c.	1	3	0	4	0	14	11	0	0	13	0	0	1	3	14
Dublin, President, Arrogant, &c.	1	2	7	3	6	14	10	0	14	8	2	14	1	3	14
Fury - -	-		-	1	2	0	4	3	0	4	2	0	0	2	0
Bittern -	-		-	2	0	7	4	2	0	4	0	14	1	0	14
Encounter -	0	3	0	1	1	7	5	0	0	4	0	0	0	3	7

	Fore Royal.			Main Course.			Main-top.			Main Top-gallant.			Royal.		
	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
Vanguard, Rodney, St. Vincent, &c.	1	0	7	14	2	0	15	0	0	3	0	7	1	2	0
Dublin, President, Arrogant, &c.	0	3	0	13	0	0	11	0	0	2	0	0	1	0	0
Fury - -	0	1	0	6	2	14	3	2	14	0	2	14	0	1	14
Bittern -	0	3	7	6	0	14	4	3	14	1	1	0	0	3	14
Encounter -	0	1	14	5	0	0	4	3	0	0	2	7	0	1	14

	Mizen Top-sail.			Mizen Top-gallant.			Royal.			Spanker.		
	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
Vanguard, Rodney, St. Vincent, &c	6	3	0	1	2	0	0	3	7	4	3	0
Dublin, President, Arrogant, &c.	5	0	0	0	3	0	0	2	0	4	0	0
Fury - -	-		-	-		-	-		-	2	0	14
Bittern -	-		-	-		-	-		-	5	0	0
Encounter -	-		-	-		-	-		-	4	0	0

A Table showing the No. of yards of Canvass of each sort in the establishment of Sails for a Ship of each Class (from First to Fifth Rate inclusive); total quantity of Canvass, number of yards of Work, with the estimated Time required to complete the same with 22 Men working 9½ hours per day.

R	Class.	Number of yards of Canvass of 24 in. required.								Number of yards of Canvass of 18 in. required.								Total of Canvass.	Yards of Work	No. of Days.
		1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8			
First.	1st	5493	6820	1040	...	2989	3500	1101	...	...	...	...	1730	1140	...	286	...	29092	116175	53
	2nd	[illegible]	6290	956	...	2632	[illegible]	209	...	...	...	...	1716	1080	...	287	...	22537	110054	50½
	3rd	4824	6427	872	...	2532	3224	1134	...	...	...	...	1550	1080	...	287	...	21354	105110	46
Second	1st	5959	6870	1040	...	[illegible]	[illegible]	1104	...	...	...	...	1766	1140	...	287	...	24691	117628	53¼
	2nd	5565	[illegible]	946	...	2606	3452	1209	...	...	...	...	1830	992	...	265	...	23461	111937	51
Third.	3rd	4837	5429	872	...	[illegible]	3212	1154	...	...	...	...	1639	984	...	265	...	21305	105207	48
	4th	1742	5369	812	...	2423	3137	1066	...	...	...	...	1677	960	...	265	...	20150	100766	46
Fourth.	1st	5014	5433	812	...	2223	[illegible]	1066	...	...	...	...	1707	960	...	265	...	20738	102703	47
	2nd	442	5019	744	...	1744	3226	936	...	...	...	...	1460	916	...	225	...	18681	93729	43
Fifth.	3rd	3332	3469	1783	694	682	1225	2639	561	...	...	...	1245	...	860	225	...	16815	86447	39¼
	4th	3039	2954	1619	694	524	1039	2401	529	...	...	...	1292	...	800	197	...	14491	90795	37
	5th	3020	2405	1488	632	129	1216	2646	479	...	...	...	1109	...	760	167	...	14130	75948	34¼

Unquestionably, all topsails and courses should be fitted with reef lines.

It is well to fit all fore and main top-sails alike, as to length of points in the different reefs, in the event of having to use a fore top-sail on a main top-sail yard.

Sails are sometimes made use of for the purpose of stopping leaks, by *thrumming* them, as in making a mat. A quick way to prepare a sail for this purpose, is to pour hot pitch on it, and then tread oakum over it.

The following Tables show the number of pairs and points of different lengths which one man can make in a day, and also the length, number, and weight of points in the sails of each class of ship.

One Man's Work per Day.

Feet.	Inches.	Pair.	Feet.	Inches.	Pair.
6	6	4	4	3	7
6	0	5	4	0	7
5	9	5	3	9	8
5	6	5	3	6	8
5	3	5	3	3	9
5	0	6	3	0	10
4	9	6	2	9	12
4	6	6	2	6	13

1*st and* 2*nd Class Ships.*

Reefs.	ft.	in.	ft.	in.	No. of points.
Fore Course - - -	3	6			98
Fore Topsail, 1st reef - -	5	6	4	6	98
„ 2nd „ - -	5	9	4	6	120
„ 3rd „ - -	6	6	5	9	140
„ 4th „ - -	6	6	6	6	154
Main Course - - -	3	6			112
Main Topsail, 1st reef - -	5	6	4	6	112
„ 2nd „ - -	5	9	4	6	130
„ 3rd „ - -	6	6	5	9	164
„ 4th „ - -	6	6	6	6	176
Mizen Topsail, 1st reef - -	3	6	3	0	74
„ 2nd „ - -	4	0	3	6	80
„ 3rd „ - -	4	6	4	0	100
„ 4th „ - -	4	6	4	6	120

Total No. of points, 1678: Weight of do., 12 cwt. 1 qr. 4 lbs.

3rd and 4th Class Ships.

Reefs.	ft. in.	ft. in.	No. of points.
Fore Course - - -	3 6		84
Fore Topsail, 1st reef - -	5 3	3 9	84
" 2nd " - -	5 6	4 3	96
" 3rd " - -	5 9	4 9	120
" 4th " - -	6 0	6 0	132
Main Course - - -	3 6		96
Main Topsail, 1st reef - -	5 3	3 9	93
" 2nd " - -	5 6	4 3	110
" 3rd " - -	5 9	4 9	140
" 4th " - -	6 0	6 0	156
Mizen Topsail, 1st reef - -	3 6	3 0	60
" 2nd " - -	4 0	3 6	84
" 3rd " - -	4 6	4 0	90
" 4th " - -	4 6	4 6	100

Total No. of Points, 1448: Weight of do., 11 cwt. 0 qrs. 15 lbs.

1st and 2nd Class Frigates.

Reefs.	ft. in.	ft. in.	No. of points.
Fore Course - - -	4 0		84
Fore Topsail, 1st reef - -	5 3	3 9	76
" 2nd " - -	5 6	4 3	80
" 3rd " - -	5 9	4 9	124
" 4th " - -	5 9	5 9	128
Main Course - - -	4 0		96
Main Topsail, 1st reef - -	5 3	3 9	96
" 2nd " - -	5 6	4 3	100
" 3rd " - -	5 9	4 9	148
" 4th " - -	5 9	5 9	152
Mizen Topsail, 1st reef - -	3 6	3 0	60
" 2nd " - -	4 0	3 6	64
" 3rd " - -	4 6	4 0	96
" 4th " - -	4 6	4 6	100

Total No. of points, 1404 : Weight of do., 10 cwt. 0 qrs. 14 lbs.

Fore C[illegible]
Fore T[illegible]
[illegible]
[illegible]
[illegible]
Main C[illegible]
Main T[illegible]
[illegible]
[illegible]
[illegible]
Mizen T[illegible]
[illegible]
[illegible]
[illegible]

Total N[illegible]

Fore Course	
Fore Top[illegible]	
"	[illegible]
"	[illegible]
"	[illegible]
Main Course	
Main Topsail,	[illegible]
"	2nd
"	3rd
	4th

[illegible]

3rd and 4th Class Frigate.

Reefs.	ft. in.	ft. in.	No. of points.
Fore Course - - - -	3 6		72
Fore Topsail, 1st reef - -	5 3	3 9	74
„ 2nd „ - -	5 6	4 3	78
„ 3rd „ - -	5 9	4 9	116
„ 4th „ - -	5 9	5 9	120
Main Course - - -	3 6		84
Main Topsail, 1st reef - -	5 3	3 9	84
„ 2nd „ - -	5 6	4 3	88
„ 3rd „ - -	5 9	4 9	132
„ 4th „ - -	5 9	5 9	136
Mizen Topsail, 1st reef - -	3 6	3 0	56
„ 2nd „ - -	4 0	3 6	60
„ 3rd „ - -	4 6	4 0	88
„ 4th „ - -	4 6	4 6	92

Total No. of points, 1270 : Weight of do., 6 cwt. 1 qr. 11 lbs.

5th and 6th Class Frigate.

Reefs.	ft. in.	ft. in.	No. of points.
Fore Course - - - -	3 6		64
Fore Topsail, 1st reef - -	4 6	3 6	64
„ 2nd „ - -	4 9	3 9	68
„ 3rd „ - -	5 9	4 9	104
„ 4th „ - -	5 9	5 9	108
Main Course - - -	3 6		76
Main Topsail, 1st reef - -	4 6	3 6	76
„ 2nd „ - -	4 9	3 9	80
„ 3rd „ - -	5 9	4 9	120
„ 4th „ - -	5 9	5 9	124
Mizen Topsail, 1st reef - -	3 6	3 0	48
„ 2nd „ - -	3 9	3 3	52
„ 3rd „ - -	4 6	3 9	84
„ 4th „ - -	4 6	4 0	88

Total No. of points, 1156 : Weight of do., 5 cwt. 2 qrs. 9 lbs.

7th and 8th Class Frigate.

Reefs.	ft. in.	ft. in.	No. of points.
Fore Course - - -	3 0		56
Fore Topsail, 1st reef - -	3 6	3 0	56
„ 2nd „ - -	3 9	3 0	60
„ 3rd „ - -	4 6	3 9	88
„ 4th „ - -	4 6	4 6	92
Main Course - - -	3 0		64
Main Topsail, 1st reef - -	3 6	3 0	64
„ 2nd „ - -	3 9	3 3	68
„ 3rd „ - -	4 6	3 9	104
„ 4th „ - -	4 6	4 6	108
Mizen Topsail, 1st reef - -	3 0	2 6	44
„ 2nd „ - -	3 6	3 0	48
„ 3rd „ - -	4 0	3 6	72
„ 4th „ - -	4 0	4 0	76

Total No. of points 1000 : Weight of do., 3 cwt. 1 qr. 20 lbs.

1st and 2nd Class Brig.

Reefs.	ft. in.	ft. in.	No. of points.
Fore Course - - -	3 0		52
Fore Topsail, 1st reef - -	3 6	3 6	52
„ 2nd „ - -	3 9	3 3	56
„ 3rd „ - -	4 6	3 9	84
„ 4th „ - -	4 6	4 6	88
Main Course - - -	3 0		60
Main Topsail, 1st reef - -	3 6	3 0	56
„ 2nd „ - -	3 9	3 3	60
„ 3rd „ - -	4 6	3 9	92
„ 4th „ - -	4 6	4 6	96

Total No. of points, 692 : Weight of do., 2 cwt. 3 qrs. 8 lbs.

SAIL TACKLE.

It is our business to handle spars and sails under such very different circumstances, that it is impossible to make a law for the arrangement of the sail tackle and its fall as usually worked. The sail tackle is heavy, and supposed to be strong enough singly for shifting top-sail yards with, but although equal to the *weight* of these spars, experience has shown that it is not able to stand the heavy and sudden strains which are thrown on it when the spar butts, as it so often does, against the tops, and consequently the long tie is generally used in addition. This plan is not only safer, but on an average, quicker. The tie is so strong that the sail tackle may be rove of lighter rope, and kept in the top altogether without inconvenience. Round it up long enough to reach from the top-mast head to the lower cap, and coil it on the top battens; send the fall on deck, place it in a constant lead and keep it coiled up in a rack. In large ships the main deck is the best place for the fall, as there is not only more *run*, but the men will be less exposed in shifting yards. Thus every one will know where the sail-tackle fall is, and when in any case the tackle is used aloft, the fall may be worked without delay or mistake. Fit a strop on the top-mast head on the side opposite the long lie, and stop it along the legs of the stay. Keep a rounding line with a weight on its end coiled down on the lower cap, and a tricing whip from the top-mast head inside the rigging for the sail tackle. In shifting yards, the lower block of the tackle, when triced up, will be flush with the yard. If for sails, the rounding line is hooked on to the lower block, and the end thrown down to the deck, before or abaft the main yard, or through lubbers' hole, as the case may require. As with the sail tackle thus worked nothing can be done with the rounding line until the yards are down, the topsails should be lowered as soon as possible, and the weather clue line run up.

BENDING SAILS.

Fit all the square sails with gaskets; seize them on their head at equal distances; make the lanyards a fathom long; and put marks with knots, so that when hailing the yard from the deck the gasket that may be alluded to can be denoted by its number from the bunt.

By tying sails up with temporary fastenings, there is not only great waste of spun yarn, but injury done; for ignorant hands always cut *at* the sail in cutting loose, instead of entering their knife and cutting towards themselves. It will prevent many vexatious mistakes, if the courses are marked at the bending places of the different gear with a piece of duck sewn on the sail bearing the initials of the particular rope which should be made fast there; (thus, S. I. L., Starboard Inner Leech line, and so on;) and also to plait some bunting into the robands at these places; for in sending courses up furled, nothing will go well unless the leech lines be fast to the head of the sail *exactly under* their own blocks which are on the yard.

There can be no question about the superior neatness and efficiency of making it a habit to send sails, both up and down made up just as if furled. Indeed, when blowing strong at anchor head to wind, there is no alternative.

In making them up, the main point to aim at is keeping the yard-arms as light as possible, so that the sail may haul out taut all along more easily. Lower the upper yards, and stop the yard ropes out of the way.

Seize the setting strops to the heads of the sails at the middle eyelet holes; let them always remain there, and when using them after the sail is rolled up, carry the foremost leg round the after one, and seize its bight to its own parts. Top men are very apt to cut this seizing too soon; but by having the strop fast to the head, their mistake may be partly remedied by a pull on the sail tackle, which is always hooked to the after leg.

TOPSAILS.

Haul the head of the topsails along the deck after sides downwards; gather all the slack canvass back from the head; lay the second reef band along the head, and haul this and the head taut fore and aft by the earings. Bring the leeches as far as the reef tackle cringles along the head; knot the fourth reef earing into the third reef cringle, and the third into the second; carry the clues into the quarters about six feet over the head; bring the buntline toggles about a foot over the head between the clues; coil all the remainder of the roping so as not to ride, leaving the bowline *cringles out;* face the foot and gather up; then face the

head and roll up; pass the gaskets taut; stop the clues up abaft the head after having passed them over the fore part of the bunt; seize the strop; hook the sail tackle; knot the second reef earing into the first reef cringle, the first into the head; and stop the head earings along the top of the sail on each side. Send the buntlines down on the same side of the lower stay with the sail tackle. Toggle them, and then hitch their bights round the quarters of the sail on their own sides about a fathom outside the strop. Bend a bowline of the side to the strop of the sail tackle block to guy it off the top rim. When the clues of the sail have been swayed above the top rim, and the turns slewed out, take turns with sail tackle falls and buntlines. Bend the reef tackles to the second reef cringles; and keep a good strain on the buntlines as the sail tackle is lowered on hauling the reef tackles out. If the quarters are allowed to get below the yard, they are not easily raised. Carry the head earings out to the yard-arms; haul the head of the sail taut along the yard; tie the robands; lash the clue lines; shackle the sheets; bend the reef tackle to its proper cringle; toggle the bowlines; cast the hitch off the buntlines and the seizing off the strop; toss the sail up, &c.

COURSES.

Haul the heads of the Courses taut along, roping downwards (*i. e.* after sides on the deck) on top of the setting strop, and make the earings fast. Gather the sail back from the head, and then lay the second reef band on the head, hauling its earings also taut out. Bring the leeches in taut, as far as the inner leech line cringle, and lay them on the head. Lay the clues over the head, about six feet on each side of the middle of the sail, and the buntline toggles about a foot over the head between them. Place the men along the head, and gather up as in furling; throw the skin over; let the men step across, and roll up; pass the gaskets, footing them well taut: let go the earings, coil and stop them up; pass the foremost leg of the strop over the bunt of the sail, round the after leg of the strop, and seize its bight to its own parts. Make the stay whip fast well up on the slings, and hook on to the after leg of the setting strop. Sway the sail up and down, till its after part is aft, and when clear of turns, hook the ef tackles to the second reef cringle over the *tacks and sheets*, l *haul* the arms out to the sides, lowering the whip sufficiently

to bend the bunt lines, leech lines, tacks, sheets, and clue garnets. Hang the clues to the strop of the whip block before the bunt of the sail.

Get the distance of each leech line block on the yards *from the slings* with a piece of line, and rack the leech lines to the heads of the sails, *exactly* at those distances from the middle of the sail, taking care that the leech lines are clear of each other and the inner one racked inside the outer.

Overhaul the clue garnets, and tacks, and sheets well. If bending all together, trice booms up, sway the courses close up with the stay whips, and the topsails with the sail tackles. When the clues of the topsails are over the top rims, send sail-furlers aloft, man the reef tackles and leech lines, lay out, and haul all the sails out together.

If the leech lines have been racked just under each leech line block, the courses will haul taut along the yard, so that two hands might bend the courses. Round up the clue garnets, bring to the heads of the sails, cut the seizing of the setting strop, leaving the strop on the head, pass the lanyards of the gaskets round the jack stays.

When the robands of courses are made longer than usual they answer quite well for reef points, and on all the yards it is very convenient to have two on each quarter, long enough to pass round the sail when the gear has been so ill bent as not to haul it quite taut along the yard.

SPANKER.

Sway the gaff three feet off the boom, guy the peek over a little to the side on which the sail lies; make the guy and halyards fast. Secure the head earing by putting in two eyebolts or "lugs" some two inches apart on the under side of the jaws, score the wood out between them, put the head cringle in edgeways, run a bolt or toggle through all, and seize it; lay the head of the sail along the gaff, passing it through the brails, but by *no means allow it to be stretched in the very least degree.* The disease of "drivers" commences on the taffrail, and not in the sail loft: the afterguards jiggers occasion all the perpetual doctoring of spankers, and abuse of our own sail cutters. Lace from the throat, and then make *the peek earing fast* with up and down and outer turns.

Let go guys, vangs, brails, &c. &c.; sway the gaff up, seizing the hoops on above the reefs as the sail rises. Reeve a soft greasy lacing below this, make the tack fast on the boom close to the mast, and hoist the luff up well taut. Put a light whip on the boom near the end, gather the sheet of the sail out, top the boom, and reeve the outhauler through whichever of the reef cleats on the boom the sheet, when barely hand taut, reaches; if it is short of them, lash a block on the boom for the purpose, and bend and take through the slack of the outhauler; then raise the peek, belay and rack all the halyards, and let the sail hang thus as long as convenient. As it is used, it will now give out equally all over, the outhauler being proportionally shifted out, and it will stand as well as any canvass not cut on the thread can do.

Seize the brails on the after leech in their exact places the first time the sail is hauled up, as before described.

HEAD SAILS.

Make the jibs up as if they were furled: mark the stays with a yarn at the nips at the boom ends, and overhaul them and the downhauls in on the forecastle. Unhook the reeving lines, and reeve the stays down from head to tack, and the downhauls up from tacks to heads through the cringles; make the downhauls fast to the heads, and the reeving lines to the stays. Stop the luff of the sails to the stays above the marks. Bend the halyards to the heads, and take a hitch with their bights round the sails, near the hanks, making fast with a seizing. Pull up the halyards, haul out on the reeving lines and down hauls, and lower the sails to their places; toggle the sheets, set up the stays, cast the hitch off the halyards, make fast the tacks, and reeve the lacings.

Lacings of fore and aft sails must be passed from the sail round the fore part of the stay or spar only, not in round turns.

Carry the stay sail out by the halyards and downhaul, seize the hanks on outside, and toggle the sheets.

TOP GALLANT SAILS AND ROYALS.

Lay the yards on the deck, reeve the yard ropes through the grummets and lizards, and clench them round the bunts -- *slings*, if so fitted. See that the parrels and quarter are properly seized on; bring the sails (roping next

the yard) to the jackstays with the robands, and to the yard-arms with the earings, avoiding stretching, by "riding down the head," &c., and keeping the turns of the top-gallant earings clear of the royal sheet sheave holes; furl the sails, keeping the bunt low, leaving the bridles and clues out, and pass the gaskets well taut. Stop the yard ropes down with the lizard and grummet on the upper yard-arm sides; overhaul the lifts and braces, hang the bight of the lower royal braces with a yarn at the top-gallant mast heads. Observe that nine out of ten of the mistakes made with upper yards are occasioned by the impetuous rush of the working parties, which either carries the yards past the riggers, or else whips them out of the lower lifts before there is time to take their slack down; therefore, station an experienced man who will bring all to a stand still on the rise of a finger with his back stopper: name men to rig each upper and each lower yard-arm, to bear off in the top, and then take down the slack of each of the lower lifts, to bear off on the cross trees, and to parrel.

Sway the yards up, keeping the top-gallant below the royal. When the upper yard-arms are over the top-mast and top-gallant stays "*stopper*," make the working parties face forward, and mark the yard ropes at the bitts with a piece of bunting put through the strands; knock the grummets off; rig the yard-arms; haul the lower lifts taut; and sway across by gathering the yard ropes up hand over hand, and slipping the lizard hitch (if used) when it is high enough, parrel immediately; square by the lifts, and then cut the stop of the lower royal braces; bend the sheets, and clue lines, and bow lines; make a tackle in the tops with the bights of the halyards, the upper block of which toggles to the standing part. See that the top-gallant masts are upright, and then get squaring marks on the lifts.

BOOM MAIN SAILS.

The *Boom main sail* is bent like the driver, but the sheet is made fast to the boom, sometimes to a traveller, which is eased in or hauled out at pleasure. Two at least of the reef pendants are always rove; the others are rove as required. The whips on each side of the jaws of the gaff act as downhauls, or for the purpose of tricing the tack up.

The *wear and tear*, and unequal stretch on the sheet of a boom

mainsail is much decreased by having reeving lines through the reef cleats, through the reef cringles to beckets in the ends of the pendants, and keeping the pendants unrove from the sail and stopped up on the after end of the boom.

Main try-sail is brought to the gaff with a lacing, and to the mast with hoops, having brails led as the driver.

TRY SAILS.

Try-sail gaffs are usually fixtures, or "*standing.*" In some cases the pendants by which they are hung are carried out to the point of the gaff, and the head of the sail, instead of being laced, is made to run in or out on the gaff by means of hoops and out and in haulers. They are said to be more manageable in this way.

STUDDING SAILS.

The Studding sails are laced to their yards, furled square on their heads, tacks, sheets, and downhaul cringles being left out, and are tied up with "centipede" gaskets. On being bent, they are more tidily kept when stopped up and down the masts and covered. On the booms they are "caulked" in, and in the rigging they hold wind, strain the strouds, and have no chance of being kept dry.

A ready way with a lower studding sail, is to make the sail up square on the whole of the head, and have a strop with a slip toggle round it, at the place where the halyards are to be bent. Trice it up and down the mast by its middle; stand the yard on the deck with its outer arm *downwards*, and let the part with the yard be outside of that without any; secure them in that position. When you want to set it, run the part without the yard (which is in fact the inner part of the head) up with the inner halyards; bend the outer halyards to the yard; cast off the stops; pull the tripping line up so as to clear the lower yard arm of the nettings; and then run the halyards out, slipping the toggle when the yard is half way up. All this will be done with much less time, soiling of hammocks, and bungling than otherwise.

It is usual to unbend stud sails if not much in use, bending them as required. The whole business of bending sails, has been often done, without a word of preparation, in order and precision in a line-of-battle ship in fifteen minutes.

MAKING SAIL.

After bending, it is well to make all sail and move the yards about to show everything its place; getting braces, buntlines, &c. &c., marked so as to avoid occasion for unnecessary noise and delay in shortening and furling sail, squaring yards, &c. &c.

In sheeting home topsails, the sheets, if double, should be stopped together, having hands at the lower yard-arms, outside the lifts, to cut the stops when they have reached them; and in all cases before letting fall, the men should be warned off the outer quarters of the lower yards. The fall of the sheets is very violent, and the bights frequently get under the feet of the people on the lower yards. In loosing courses, it is not necessary to trice the booms up; and when the outer gaskets have been cast off, if there are no reefs to shake out, the men should come in off the yards; the booms and quarter-gaskets will keep the sails up.

When about to haul to a Bowline, if there are reefs in, let fall first, and shake the reefs out. Before hauling out, warn people out of the fore part of the tops, and in all places where they are likely to be holding on by the buntlines.

FURLING SAILS.

The yards are usually marked on the quarters, so that the men may be kept within certain bounds before the order to lay out is given. If furling from a bowline, stop the bowlines, and haul them through before clewing up.

If working with "*beginners*," do not haul the buntlines up above the yards until the reefs are in: the state of the reefs can thus be seen. Indeed, to get the reefs well taken in, it is best when all the furlers are aloft to pipe reef topsails; "one reef," "second reef;" causing the topsail yard men to come in each time; and then if the reefs are satisfactory, pipe "furl sails," and "lay out" altogether.

Lowering booms the first ship is mostly an imposition, and in no case a proof of exceeding smartness. It is a mere matter of position of bunt becket. If that is low, or in other words if the bunt be great, run the buntlines right up, having a hand stationed to ride each one down, pull up the bunt whip, and lower the *buntlines*. The bulk of the sail falls into a huge unship-shape

looking triangle, the booms are lowered, and the sails are said to be furled. But it comes on to rain heavily; the sails are filled with water, and as long as there is no opportunity for drying, we have drip on deck and decay aloft.

The sails are not furled in this case; nor are they, in any case until every single man has done patching, and every man is down from aloft.

To furl a sail well, every cloth must be *handed;* that is, gathered up in handfuls; and each handful *stowed.* When this is done, let all hands lay hold of the skin all along; shake the slack canvass into it, and then toss the sail up, bringing the skin as a covering over the upper side of it. The bunt in this way will be low and round. The end bunt gaskets are passed abaft the top-masts across to opposite sides, and down into the top where these are set up. The outsides only will be wetted in the event of rain, and will dry without even being loosed.

It is considered neat practice to cause all the men not stationed for squaring yards to quit the tops at the pipe "Down booms;" and then, when the upper yards are squared, to pipe the remainder down together.

The evolution is not completed whilst even one straggler is above the netting.

CHAP. XVIII.

ACTION OF WIND UPON SAILS.

BEFORE considering the action of wind upon sails, it may be well to define the meaning of certain terms which it will be necessary to make use of.

The *Area* of any plane surface is the measure of the space contained within its boundary lines, which is usually expressed in square yards, or feet, or inches, without reference to shape.

Thus, supposing the sides A B (*fig.* 197.) and A C to be each equal to one foot, the area of the whole figure would be one square foot, and that of either of the triangles A B C or B C D would be half a square foot; or if the square A B C D were divided into two equal portions, and one of these were placed underneath

so as to form the rectangle A E F G (*fig.* 198.), this rectangle would have the same *area* as the original square.

Fig. 197.

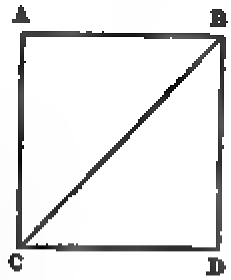
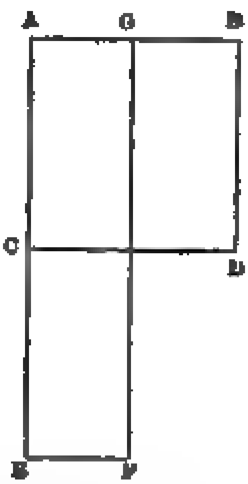
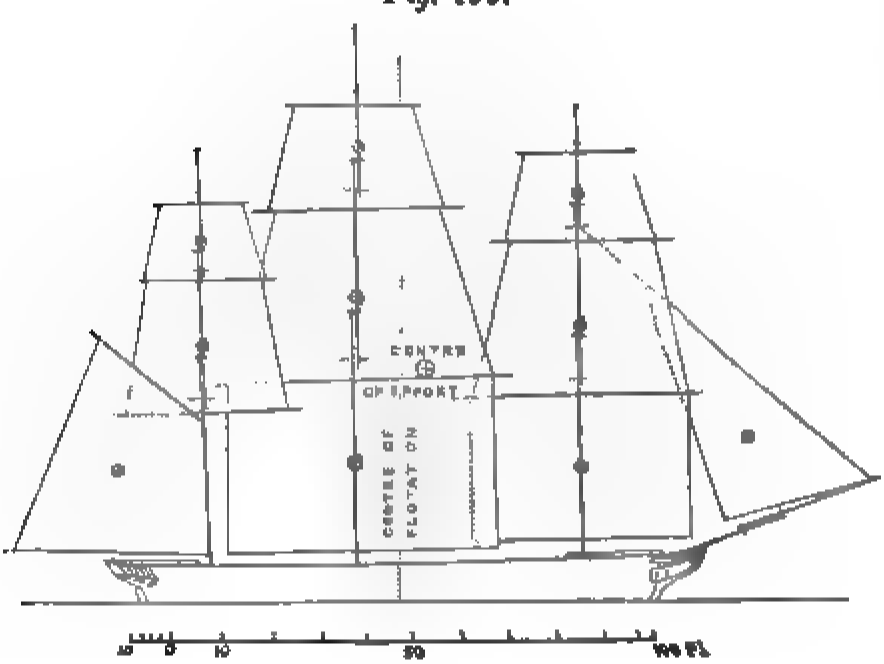


Fig. 198.



The *Centre of Effort* means that point in the area of a sail upon which, if the power of the wind were concentrated instead of being diffused over the whole surface, the effect upon the ship would be the same. The term applies not only to the power of one, but to the combined power of any number; for instance, let the small circles on the sails in the figure 199. be the centres of effort, then the common centre would be about the large circle, which position would depend on the relative size of the sails, and might be determined by the same means which are used for ascertaining the position of the centre of gravity of any surface.

Fig. 199.



The *Axis of rotation* is an imaginary line round which the ship turns in obedience to the action of either the helm or sails. The position of this line is affected both by the trim of the ship, and her speed. It will be drawn aft or forward as the ship sinks by the stern or the head.

The power of the sails is opposed by the action of the water on those immersed portions of the ship which are called the area of lateral resistance, A B (*fig.* 200.), and the area of direct resistance, *a b* (*fig.* 201.).

Fig. 200.

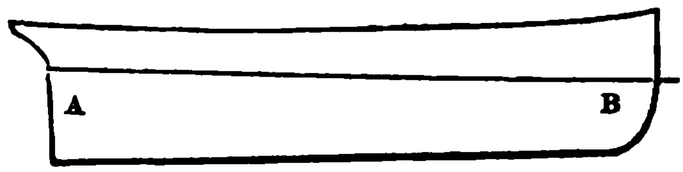
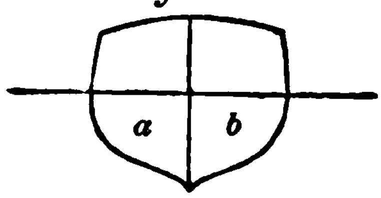


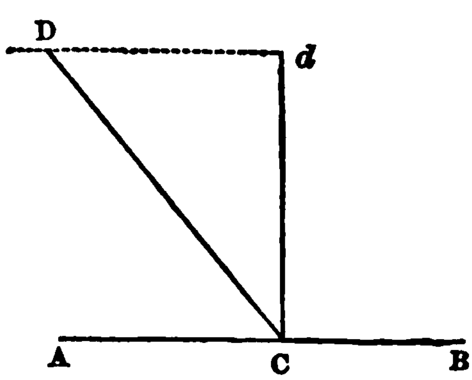
Fig. 201.



It is usual whilst investigating the effect of pressures upon surfaces to represent direction by lines, and strength by the length of those lines. When a pressure is exerted against any point on a surface, its useful effect is always in a direction at right angles to that surface. If the line be at right angles, then the effect and pressure coincide, and the pressure exerts its full force. If the line be at an oblique angle with the surface, then although the effect produced is at right angles, the power is diminished in proportion to the obliquity.

Let A B (*fig.* 202.) represent the surface of a sail, and D C the wind; the useful effect will be represented by the line *d* C both in direction and proportionate force.

Fig. 202.

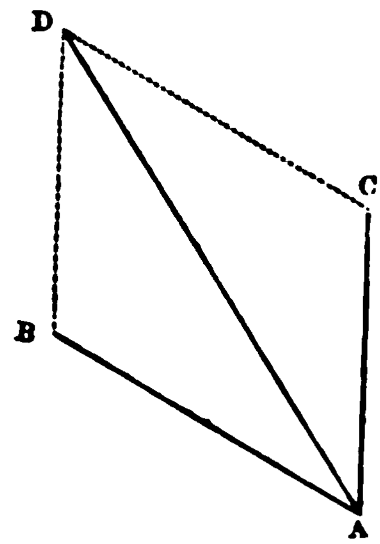


It is a law in the science of forces that when any two forces act on one point, their joint effect is the same as if one force were acting on that point in a direction between the other two. This intermediate force is called the *resultant*, and its relation both in direction and strength to that of the others is that of a diagonal in a parallelogram of which the two original forces form two adjacent sides.

Thus let B A and C A (*fig.* 203.) represent two forces acting

on A. Construct the parallelogram A B C D, and the diagonal D A will be the resultant of the two forces B A and C A, and the pressure represented by it will be equivalent to those represented by B A and C D combined, both as to direction and strength.

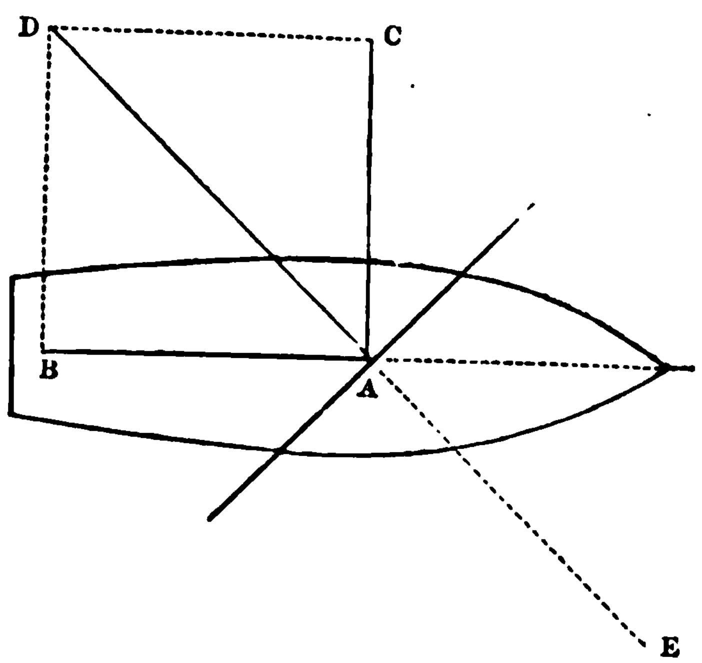
Fig. 203.



The converse of this proposition is evident, viz., that if a force D A presses on A the pressure it exerts may be represented, if convenient, by the two forces B A and C A, and this process is called resolving the force D A into B A and C A.

In the *fig.* 204. we have the wind D A exerting a certain force on the point A, the effect of which will be the same as if two forces were pressing, one across the ship, as C A, in a direction opposed to her lateral resistance; the other, as B A, in one opposed to her direct resistance.

Fig. 204.



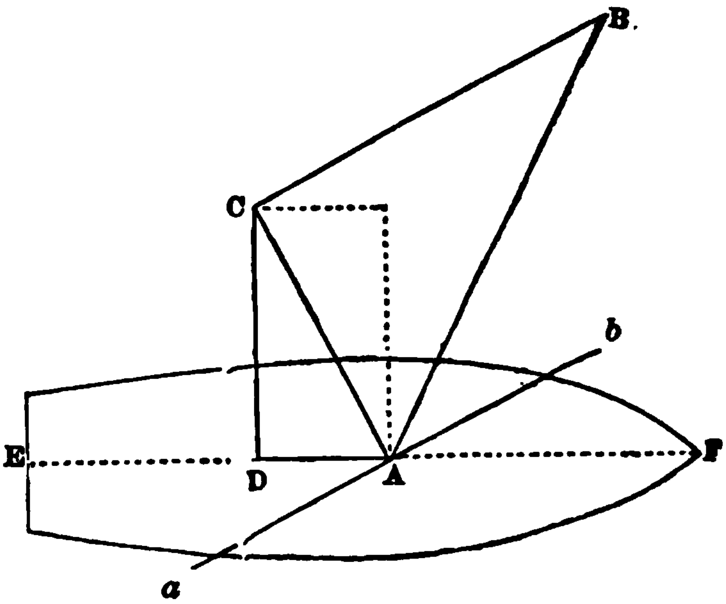
If the form of the ship were such that these resistances were in the same proportion to each other as the forces B A and C A to which they were opposed, then she would obey the absolute impulse of the wind D A, and sail on the direction of the line A E. But it being such that her lateral resistance greatly exceeds her direct resistance, she proceeds nearly in the direction B A.

Now let A B represent the wind *, and *a b* the yard (*fig.* 205.),

* It must be understood that no allusion is made here to the number of particles of wind which strike the sail, the diminution of which would decrease the force C A, as the sine ^{2} of the angle B A *b*. The mechanical force of a single particle is shown to render the subject more simple.

the effective pressure is equivalent to the line C A at right angles to the surface of the sail. This force may be again resolved into the two forces C D and D A, acting respectively to overcome the direct and lateral resistances.

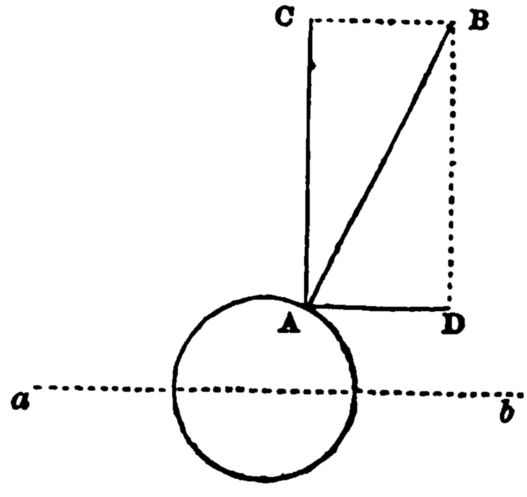
Fig. 205.



It is evident from this process of resolution of forces that the direct propelling force D A is small compared with that of C D; still, as the lateral resistance is very much greater in proportion to the direct, the ship yields chiefly to the force D A, and proceeds on a course nearly on the line E F, any deviation to leeward of which is called the angle of leeway. The amount of this leeway is more or less considerable, according to the form of the vessel, the amount of surface exposed to the wind,—which is, of course, greater as the vessel is more crank,—the set of the sea, and the resistance offered to the wind by masts, and in fact, everything except the sails.

Let A (*fig.* 206.), for instance, be a section of a lower mast, *a b* the course of the ship on a wind, and B A its direction. Resolve B A into C A and D A, and it will be evident that the whole effect of the wind is as regards the mast a retarding and leewardly one; and however insignificant it may seem in the case of a ship, it will serve at least to show the bad effects which are produced by permitting the coxswains and crews of boats to sit above the gunwale of a boat whilst under sail.

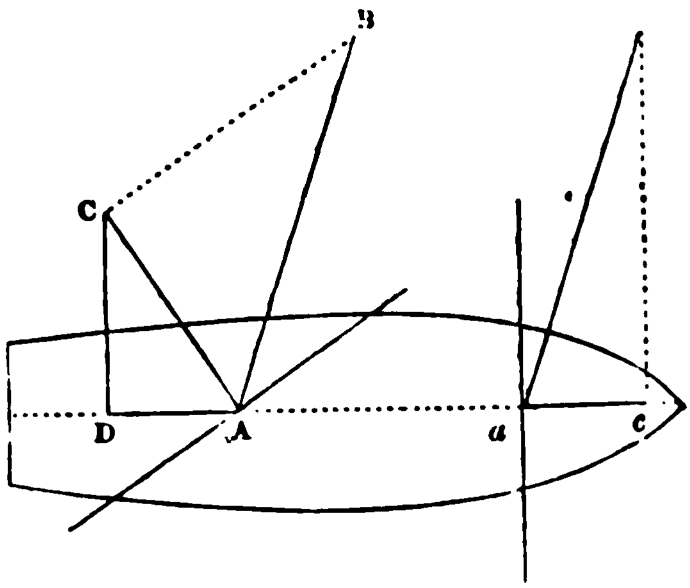
Fig. 206.



Let *fig.* 207. represent a brig "lying to" with her fore top-sail

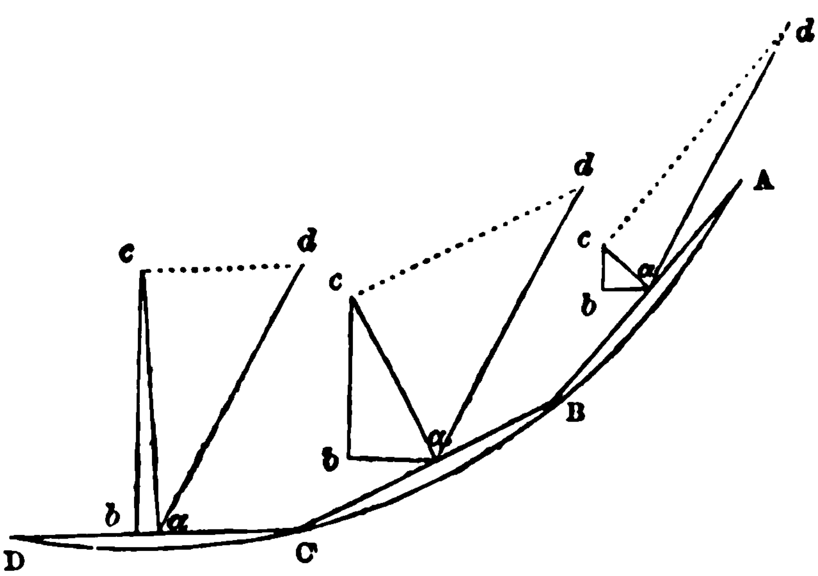
to the mast. The effect of the wind on the main top-sail in drawing the ship a-head has already been shown. With regard to the fore top-sail it will be observed that the effective force of the wind *c a* at right angles to the sail coincides with the fore and aft line of the ship. Its sole effect, therefore, is to counteract the forward pressure of the wind on the main-top-sail A D, and thus, by neutralising the ship's direct motion, keep her nearly stationary. The transverse pressure, however, on the main-topsail C D takes full effect, and the ship consequently falls bodily to leeward.

Fig. 207.



In the foregoing investigations the sails have been considered for sake of convenience to be flat on their surface. The accompanying figure will illustrate the advantage of a flat and disadvantage of a curved surface. Let the curve (*fig.* 208.), A B C D, be considered as a horizontal section of the belly of a sail

Fig. 208.



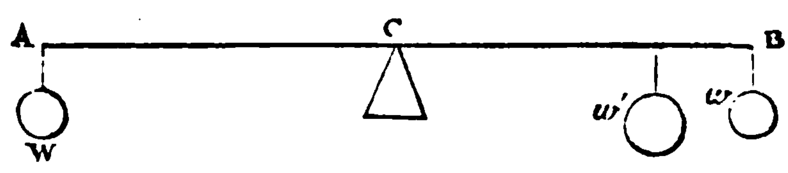
whose yard is braced sharp up, and let us suppose this curve to be composed of any number of straight lines joining each other at very *obtuse angles.* If we divide this curve into three parts,

substituting a straight line for each portion of the curve, and repeating the line *d a*, which represents the wind, in each division of the figure, we have then A B for the weathermost, B C for the middle, and C D for the leewardmost division of the sail. Now applying the principle of the resolution of forces as before, we find that in A B, the wind blows nearly along the surface, that the effective force *c a*, at right angles to the sails, is comparatively small, and the direct force *b a* is also small; but that the proportion of the direct force *b a* to the transverse force *c b* is large. In the middle division we have a larger effective and direct force, but the transverse force is assuming a larger proportion to the direct than in the division A B. Lastly, in the leewardmost portion, the effective force is still larger than before, but it is now nearly all absorbed in the transverse force, the direct one being comparatively small. From this it will appear that the weathermost portion of the sail exercises very little power on the ship, though that little is of a favourable kind; that the centre is, on the whole, doing good, but that the leewardmost division is doing harm.

It will also appear that if the sail were set flat, as in a line from A to D, the whole sail would exert as favourable a pressure as the division B C in kind, but in greater degree, and could be so set as to permit the ship to lie nearer the wind.

We come now to another division of this subject, the effect of the sails in directing the ship's course, or, in other words, in assisting the helm. This effect will, as in the case of the motive power of the sails be best understood by a simple mechanical problem, that of the lever.

Fig. 209.



A B is a lever supported by a fulcrum at C, its arms being of equal length. W is a weight attached to one of these arms. If that were the only weight attached to it, the lever would at once be thrown off its level. To restore it to its level position, it would be requisite to attach another weight equal to *w* to the other extremity — or it might be restored to its level by placing a larger weight *w′* nearer the fulcrum. The law by which the

relations of these weights are governed is this, that the product of either weight multiplied into its distance from the fulcrum must be equal to the product of the other weight multiplied into its distance from the fulcrum; or if there are more weights than one on each side of the fulcrum, the sum of the products on one side must equal the sum of the products on the other.

In the case before us, suppose the arms of the lever to be each 12 feet in length, and the weight *w* to be 3 lbs. —$3 \times 12 = 36$. Then any weight as *w* placed at the extremity of the other arm of the lever must also be 3 lbs., being at an equal distance from the fulcrum; but supposing it desirable to restore the level of the lever by placing a weight nearer the fulcrum (say at 9 feet from it), as at *w′*, then the number of pounds weight of *w′* must be such as when multiplied into 9 feet, will make 36, which in the present instance would be 4, as $4 \times 9 = 36$. The same principle holds good whether the lever be moving in a vertical or horizontal plane. If the lever A B were fixed on a vertical axis passing through the point C, so that its motion should be in a horizontal plane, the power requisite to alter its direction would require to be proportioned as above.

To apply this to the power of the sails on a ship, we may consider the ship herself as a lever turning round a vertical axis, called her axis of rotation, and the areas of the sails may be considered as so many weights or forces acting on her to turn her round her axis, the distances from the axis being measured from their centres of effort. It will be obvious that if we want to turn the ship away from the wind (or "bear up"), the full effect must be given to the sails that are nearest the bow; and the sails nearest the stern, or on the opposite side of the axis, (which may be assumed to be nearly at the middle of the ship) must as far as possible be neutralised; and *vice versâ*, to bring the ship's head up to the wind, the head sails must be neutralised, and the full effect given to the after sails. It will also be obvious that to keep the ship on a straight course, the amount of sail set on each side of the axis of rotation must be balanced by a consideration of the distances of the several sails, or, to speak more correctly, the distances of their centres of effort, from that axis.

Upon this balancing of the sail depends that quality of a ship called "carrying a good helm," by which it is meant that when

all sail is set on a wind, the rudder hangs nearly in a line with the keel, very little action of the helm, and that only weather helm, being required to keep the ship from deviating from her course. The axis of rotation being a shifting line, this correct balance can never be attained by mere calculation — but an approximation sufficiently near for all practical purposes, has been arrived at by naval architects by means of comparison with ships known to have carried a good helm.

The desirable result has usually been attained by placing the common centre of effort of all the sails a few feet before the middle line of the ship, subject of course to some little modification to meet peculiarities in the form of particular ships.

From what has been said, it is to be hoped that the reader will have little difficulty in comprehending the principles which govern the different manœuvres executed on board a ship, such as Tacking and Wearing. But he must bear in mind that these manœuvres are not entirely carried out by means of the sails, but that the rudder plays the most important part. Now the action of the rudder is dependent on the speed with which the ship passes through the water, and this again upon the power of the sails. The example of the Lever must therefore be followed with some limitation. In Wearing, for instance, while we to a certain extent neutralise the after sail, it is desirable to keep such an amount of sail in full action as to keep up the speed of the ship. This is done by not only keeping the head sails full but the main top-sail also, or very slightly lifting, the mizen top-sail and driver alone being neutralised. Again, in tacking under ordinary circumstances, so much advantage is derived from keeping way on the ship to the last moment before the sails shake, that none of the head sails are neutralised at all.

CHAP. XIX.

MEASURES AND WEIGHTS.

The earliest mark of time with which man could have been acquainted, must have been the successions of light and dark-

ness, or the division of a certain portion of time into day and night. After that, the observation of the movements of the heavenly bodies, the length and direction of shadows, the rise and fall of tides, the escape of water from vessels, and the consequent subsidence of the fluid within — would all suggest themselves as so many means of marking the rate at which time was passing. The sun-dial of Ahaz, the clepsydra, the sand-glass of the Greeks, the notched candle of the Saxons were all inventions, more or less satisfactory, for ascertaining its movements; and there is good reason for believing, that the Eastern astronomers, in early ages, measured time during their observations by the vibration of the pendulum.

We know that a revolution of the earth on its *axis* is the natural measure of our time; that the time intervening between the appearance of a star, or the sun, on the meridian of a place, and its reappearance is called, in the former case, a sidereal day, which is twenty-four hours; and in the latter, a solar day, which, in consequence of the earth having advanced on its *orbit*, is on an average nearly four minutes longer. But it may not be quite understood how science has improved upon primitive modes, and constructed a machine which, self acting for several days (if need be), and independent of temperature and the visibility of heavenly bodies, computes time with almost undeviating accuracy.

When a pendulum, however long or short, is set in motion, every swing, vibration, or oscillation which it makes, until it comes to a standstill, is performed in exactly the same amount of time.

These times will be greater or less, as the pendulum is long or short; and it may therefore be made to perform any number of vibrations in a given time.

Say that it is made to beat 86,400 times in a day, and that we divide that number into certain portions, calling them minutes and hours, and the vibrations themselves seconds. The next requirements naturally will be to contrive some means for keeping the pendulum in motion for that, or even a longer, period. This is effected by a train of wheel-work, which is kept revolving during the descent of a weight suspended by a cord wound round one of its axles.

One of the teeth of that wheel which is in contact with the axis of the *pendulum* is disengaged in a particular direction at

each vibration, and thus the pendulum in return regulates the velocity of the descent of the weight.

An indicator and dial on the end of the last axis of the train will express this velocity; and this velocity is the time as measured by the pendulum in the instance of a common clock.

It was soon found that if the weight at the end of the pendulum were equally divided—one half being fixed at each end of it, and the pendulum itself placed horizontally on an axis at its centre, and kept in motion by the constant pressure of a spring having a proportionate degree of strength— the same consequences would follow.

This arrangement, which is just the Balance Wheel produced in smaller proportions and adapted to smaller scales and any attitude or position, became the fundamental principle of the Chronometer and pocket watch.

"The compensation balance is a beautiful contrivance for counteracting the effect of changes of temperature, which, by causing an ordinary balance to expand and contract, occasion a variation in the extent of its vibration, and consequently in the rate of going of the timepiece of which it forms the essential feature. This correction is effected by forming the rim of the balance of two semicircular slips of metal, fixed at one end only, and each consisting of a very narrow riband of steel joined to an outer rim of brass. Each of these slips consisting thus of two metals differently affected by heat, is capable of altering its shape with every change in the temperature to which the chronometer is exposed, in such a way as to keep the vibrations of the balance always the same." *

The pendulum is also employed as an instrument in the measurement of *space*, as well as *time*. For things which we call fathoms, yards, feet, inches, &c., have no existence, excepting that which they derive from the pendulum.

The number of vibrations which a pendulum of a given length will make in a given time will depend on the locality of the instrument. In different latitudes, there is required a different length of pendulum to perform the same number of vibrations. In the latitude of London, for example, a pendulum 39·13 inches

* National Encyclopedia.

long, will vibrate seconds, whereas near the Equator, a lesser length would be required to perform the same duty ; and it may be observed that the bulbs are usually made capable of adjustment by means of screws.

" This difference is explained by the flattened shape of the earth, and the consequent diminished force of gravity near the equator.

" Now, as a pendulum in this country, vibrating seconds at the level of the sea would, invariably be of a certain length, that length was adopted as a basis for a system of uniform *measures* throughout the British Islands ; and in the absence, or total loss of the ordinary means, the standard measure could be declared with a line and plummet."

Table of the length of pendulum that will vibrate seconds at every fifth degree.

Degree.	Inches.	Degree.	Inches.	Degree.	Inches.
0	39·027	35	39·084	70	39·177
5	39·029	40	39·097	75	39·185
10	39·032	45	39·111	80	39·191
15	39·036	50	39·126	85	39·195
20	39·044	55	39·142	90	39·197
25	39·057	60	39·158		
30	39·070	65	39·168		

The system of Weights in England is arbitrary, almost every county having a quantity of its own. In France the measures, weights, and coinage have a definite relation to the dimensions of the earth. The meridian of Paris measured from the pole to the equator, is divided into ten million parts, each of which is called a Metre.

This metre is 39·376 inches in length, and has been adopted as the basis of a decimal system ; the multiples and divisions being expressed by a certain prefix to the metre.

As boat midshipmen are frequently employed upon commissariat service, the following tables may be found useful.

BRITISH WEIGHTS AND MEASURES.

Troy Weight.

Grains
24 = 1 dwt.
480 = 20 = 1 oz.
5760 = 240 = 12 = 1 lb.

Avoirdupois Weight.

Drachms
16 = 1 oz.
256 = 16 = 1 lb.
7168 = 448 = 28 = 1 quarter.
28672 = 1792 = 112 = 4 = 1 cwt.
573440 = 35840 = 2240 = 80 = 20 = 1 ton.
1 lb. = 14 oz. 11 dwts. 15¼ grains Troy.
1 oz. = 18 dwts. 5½ grains Troy.

N. B — 7000 Troy grains make 1 pound Avoirdupois; hence 175 pounds Troy are equal to 144 pounds Avoirdupois.

Apothecaries' Weight.

Grains
20 = 1 scruple.
60 = 3 = 1 drachm.
480 = 24 = 8 = 1 oz.
5760 = 288 = 96 = 12 = 1 lb

Long Measure.

Inches
12 = 1 foot.
36 = 3 = 1 yard.
72 = 6 = 2 = 1 fathom.
198 = 16½ = 5½ = 2¾ = 1 pole.
7920 = 660 = 220 = 110 = 40 = 1 furlong.
63360 = 5280 = 1760 = 880 = 320 = 8 = 1 mile.

A mile contains 80 chains, land measure, and a chain 100 links of 22 yards; an inch contains 12 lines.

Measure of the Circle.

Seconds (″)
60 = 1 minute (′)
360 = 60 = 1 degree (°)
32400 = 5400 = 90 = 1 quadrant.
129600 = 21600 = 360 = 4 = 1 circumference.

Wine Measure.

Pints
2 = 1 quart.
8 = 4 = 1 gallon.
336 = 168 = 42 = 1 tierce.
504 = 257 = 63 = 1½ = 1 hogshead.
672 = 336 = 84 = 2 = 1½ = 1 puncheon.
1008 = 504 = 126 = 3 = 2 = 1½ = 1 pipe.
2016 = 1008 = 252 = 6 = 4 = 3 = 2 = 1 tun.

Ale and Beer Measure.

Pints
2 = 1 quart.
8 = 4 = 1 gallon.
72 = 36 = 2 = 1 firkin.
144 = 72 = 18 = 2 = 1 kilderkin.
288 = 144 = 36 = 4 = 2 = 1 barrel.
432 = 216 = 56 = 6 = 3 = 1½ = 1 hogshead.
576 = 288 = 72 = 8 = 4 = 2 = 1½ = 1 puncheon.
864 = 432 = 108 = 12 = 6 = 3 = 2 = 1½ = 1 butt.

N. B.— The pint, quart, and gallon, for wine, ale and beer, and grain or corn, measure the same with regard to their magnitude ; 8 of these gallons make 1 bushel ; and 1 gallon contains 277·274 cubic inches, or 10 lbs. of distilled water, at 62 degrees Fahrenheit.

Dry Measure.

Pints
8 = 1 gallon.
16 = 2 = 1 peck.
64 = 8 = 4 = 1 bushel.
256 = 32 = 16 = 4 = 1 coom.
512 = 64 = 32 = 8 = 2 = 1 quarter.
2560 = 320 = 160 = 40 = 10 = 5 = 1 wey.
5120 = 640 = 320 = 80 = 20 = 10 = 2 = 1 last.

Cloth Measure.

Inches				
$2\frac{1}{4}$ =	1 nail.			
9 =	4 =	1 quarter.		
36 =	16 =	4 =	1 yard.	
27 =	12 =	3 =	1 Flemish ell.	
45 =	20 =	5 =	1 English ell.	
54 =	24 =	6 =	1 French ell.	

Square Measure.

Inches					
144 =	1 foot.				
1296 =	9 =	1 yard.			
39204 =	$272\frac{1}{4}$ =	$30\frac{1}{4}$ =	1 pole.		
1568160 =	10890 =	1210 =	40 =	1 rood.	
6272640 =	43560 =	4840 =	160 =	4 =	1 acre.

10 square chains make 1 acre ; 640 acres make 1 square milc; 30 acres 1 yard of land ; and 100 acres 1 hide of land.

Solid Measure.

Inches		
1728 =	1 foot.	
46656 =	27 =	1 yard.

1 cubic foot = 2200 cylindrical inches = 3300 spherical inches = 6600 conical inches.

MISCELLANEOUS WEIGHTS AND MEASURES.

1 acre Scotch, 1·271 acres English, or	6084 sq. yds.
1 acre Irish, 1·638 acres English, or	7840 sq. yds.
1 barrel, imperial measure	9981·86 cub. in.
„ soap	256 lbs.
1 bushel, imperial measure	2218·19 c. in.
„ Winchester	2150·42 c. in.
„ barley	50 lbs.
„ coal	88 lbs.
„ flour or salt	56 lbs.
„ oats	40 lbs.
„ wheat	60 lbs.
1 chaldron coals, Newcastle	53 cwts.
1 sack	112 lbs.

1 chain	100 links.
1 clove of wool	7 lbs.
1 fodder of lead, Stockton	22 cwt.
„ „ Newcastle	21 cwt.
„ „ London	19½ cwt.
1 gallon, imperial measure	277·27 cub. in.
„ distilled water, 60°	10 lbs.
„ proof spirit or oil	9·3 lbs.
„ former wine measure	231 c. in.
„ former ale measure	283 c. in.
„ Irish measure	217·6 c. in.
1 league	3 miles.
1 geographical mile	1·15 Eng. ms.
„ degree	69·12 Eng. ms.
1 nautical mile (mean)	6075·5 feet.
1 gross	12 dozen.
1 great gross	12 gross.
1 hand	4 inches.
1 hundred of deals	120 in No.
„ nails	120 in No.
„ salt	7 lasts.
1 last of salt	18 barrels.
„ gunpowder	24 barrels.
„ potash, soap, pitch, or tar	12 barrels.
„ flax or feathers	17 cwt.
1 link	7·92 inches.
1 line	1–12th of an in.
1 load of bricks	500 in No.
„ corn	40 bushels.
„ hay or straw	36 trusses.
„ lime	32 bushels.
„ planks, two-inch	300 sq. ft.
„ sand	36 bushels.
„ timber, squared	50 cub. ft.
„ timber unhewed	40 cub. ft.
1 mile	80 chains.
1 pack of wool	240 lbs.
1 palm	3 inches.
1 pole, woodland	18 feet.
„ plantation	21 feet.

1 pole, Cheshire	24 feet.
1 sack of coals	224 lbs.
„ wool	364 lbs.
1 seam of glass	124 lbs.
1 cubit	18 inches.
1 span	9 inches.
1 military pace	5 feet.
1 stone of meat or fish	8 lbs.
„ horseman's weight	14 lbs.
„ glass	5 lbs.
1 thousand of nails	1200
1 truss of new hay	60 lbs.
„ old hay	56 lbs.
„ straw	36 lbs.
1 tun of vegetable oil	236 gallons.
„ animal oil	252 gallons.
1 cable's length	120 fathom.

RELATIVE VALUE OF BRITISH AND FRENCH WEIGHTS AND MEASURES. FRENCH DECIMAL OR MODERN SYSTEM.

Weights.

French.	British.
Gramme	15·434 grains.
Decigramme	1·5434 „
Centigramme	0·15434 „
Milligramme	0·015434 „
Decagramme	154·34 „
Hectogramme	3·527 oz. avoird.
or	3·2154 oz. troy.
Kilogramme	2·6795 lbs. troy.
or	2·2048 lbs. avoird.
Myriagramme	26·795 lbs. troy.
or	22·048 lbs. avoird.
Quintal	1 cwt. 3 qrs. 24½ lbs.
Millier or bar	9 tons 16 cwt. 3 qrs. 12 lbs.

Measures of Capacity.

Litre *	61·028 cubic inches.
or	1·761 imperial pint.

* The Litre = a cubic decimetre.

Decilitre - - - - -	6·1928 cubic inches.
Centilitre - - - - -	0·6103 „ „
Millilitre - - - - -	0·0610 „ „
Decalitre - - - - -	610·28 „ „
or - - - - -	2·2 imperial gallons.
Hectolitre - - - -	3·5317 cubic feet.
or - - - - -	2·75 imperial bushels.
Kilolitre - - - - -	35·317 cubic feet.
Myrialitre - - - -	353·17 „ „

Measures of Length.

Metre - - - - -	39·371 inches.
Decimetre - - - -	3·9371 „
Centimetre - - - -	0·39371 „
Millimetre - - - -	0·039371 „
Decametre - - - -	32·809 feet.
Hectometre - - - -	328·09 „
Kilometre - - - -	1093·6 yards.
Myriametre - - - -	6·2138 miles.

Measures of Superfices.

Are * - - - - -	119·60 square yards.
Deciare - - - - -	11·960 „ „
Centiare - - - - -	10·764 square feet.
Milliare - - - - -	155·00 square inch.
Decare - - - - -	1196·0 square yards.
Hectare - - - - -	2·4712 acres.

Measures of Solidity.

Stere † - - - - -	35·317 cubic feet.
Decistere - - - - -	3·5317 „ „
Centistere - - - -	610·28 cubic inches.
Millistere - - - -	61·028 „ „
Decastere - - - -	13·080 cubic yards.
Hectostere - - - -	130·80 „ „

NOTE.—The decimetre, centimetre, and millimetre, are respectively formed by dividing the metre by 10,000, and 1000 ; and the decametre, hectometre, kilometre, and myriametre, by

* The Are = a square decimetre.
† The Stere = a cubic metre.

multiplying the metre by 10, 100, 1000, and 10,000; the other measures and weights of the decimal system are formed in a like manner from their respective units.

RELATIVE VALUE OF BRITISH AND FOREIGN MEASURES OF LENGTH.

Country or Place.	Name of Measure.	No. equal to 100 Eng. feet.	Country or Place.	Name of Measure.	No. equal to 100 Eng. feet.
Amsterdam -	Foot	107·71	Naples -	Palmo	115·60
Antwerp -	...	106·76	Prussia -	Foot	97·16
China - -	...	94·41	Riga - -	...	111·21
Copenhagen -	...	97·16	Russia - -	...	87·27
Dantzic -	...	106·19	Sardinia -	Palmo	122·69
France - -	...	91·46	Sicily - -	...	125·91
Genoa - -	Palmo	123·45	Spain - -	Foot	107·91
Hamburg -	Foot	106·38	Sweden -	...	102·73
Lisbon - -	...	92·73	Venice -	...	87·71
Malta - -	...	107·52			

RELATIVE VALUE OF BRITISH AND FOREIGN COMMERCIAL WEIGHTS.

Country or Place.	Weights.	No. equal to 1 cwt. British.	Country or Place.	Weights.	No. equal to 1 cwt. British.
Alexandria -	Rottolo, For.	119·84	Malta - -	Rottolo	64·17
Amsterdam -	Pound Flem.	50·79	Naples - -	Cantaro gro	56·99
Algiers - -	Rottolo	94·12	Persia - -	Batman	88·31
Barcelona -	Pound	126·97	Portugal -	Pound	110·68
Cairo - -	Rottolo	117·89	Prussia - -	...	108·60
China - -	Catty	84·00	Riga - -	...	121·51
Constantinople	Oke	39·53	Rotterdam -	...	102·82
Copenhagen -	Pound	101·55	Russia - -	...	124·08
Cyprus - -	Rottolo	21·35	Sardinia -	...	128·00
Dantzic - -	Pound	108·42	Sicily - -	...	160·00
France - -	Livre usuel	101·59	Smyrna - -	Oke	39·53
Genca - -	Pound, heavy	145·69	Spain - -	Pound	110·40
Hamburgh -	Pound	104·86	Sweden - -	...	149·33
Japan - -	Catty	86·15	Trieste - -	...	90·75
Leghorn - -	Pound	149·61	Tripoli - -	Rottolo	100·00
Madeira - -	...	110·79	Tunis - -	Rotul	100·85
			Venus - -	Pound, new	50·79

LEAD LINES.

The hand leads are from about 7 to 14 pounds weight. The lines are marked thus: black leather at two fathoms with a hole in it; at three, the same; at five, white; at seven, red; at ten, black leather; at thirteen, blue; at fifteen, white; at seventeen, red; and two knots at twenty.

The deep sea lead line is marked in the same way up to twenty fathoms, then one knot at twenty-five fathoms, three at thirty, &c.

LOG LINE.

The first part of the log line is stray line, its object being to permit the "log ship" to get well clear of the influence of the eddy water in the ship's wake. No account of it is taken; but at the first mark, the divisions for the measurement of the ship's pace commences: this mark is a piece of white bunting.

The divisions are denoted by knots which are at distances from each other, bearing the same proportion to a nautical mile that the time run by a sand-glass does to an hour. If one of these knots pass in the interval, the ship is sailing at the rate of one mile an hour; if two knots pass, two miles an hour; and so on.

In this operation, a 28-second glass is generally used; in which case the knot should be 47 feet 3 inches, which bears the same proportion to 6075·5 (the feet contained in a mean nautical mile) that 28 seconds do to 3600, the seconds contained in an hour. When a 14-second glass is used, the knots must be doubled, or a log-line having half-knots used. The length of the knot is frequently taken as little as 44 or 45 feet, by which means the sailing of the ship is overrated. This is done with a view that the reckoning of the ship may be on the safe side in making land. This space of 47 feet 3 inches is considered as made up of tenths."*

MEASURING DISTANCE BY SOUND.

Sound flies at the rate of 1142 feet in a second, or about a mile in 4½ seconds; or a league in 14 seconds; or 13 miles in a

* Inman's Navigation.

minute ; but sea miles are to land miles nearly as 7 to 6, therefore sound moves over a sea mile in 5¾ seconds, nearly, or a sea league in 16 seconds. Sound can be heard nearly twice as far on the water as on the land. Thus, by observing with a watch or otherwise, the time which passes between the flash of a gun and the sound of the discharge, the distance from the place of the discharge may be reckoned. The same with lightning.

The banks of rivers sometimes echo any sharp noise produced upon the water, and this in a dark night on a broad river may be useful ; for by striking the water a smart blow with the flat of an oar, and observing the time between it and the echo, the distance from the bank may be guessed at.

Time may be counted by the pulsations of the blood, which, for a man in health, are usually 75 in a minute.*

CHAP. XX.

ORGANISATION.

BERTHING.

As there can be no discipline established until the hammocks and bags are marked and issued, and the berthing list completed, the earliest attention should be given to these matters. Hammock cloths take a long time in drying, and should be drawn and fitted as soon as possible. The forecastle cloths stand all the better for being sewn with the seam athwart ships.

In berthing, the lower deck guns must be run in and howsed, as at sea. Boatswain's mates are berthed at the hatchways, other petty officers next the sides; thus they get a little more space, and protect the mess traps.

The guard and quarter-masters are best disposed of in the wings, or any where out of the gangways; so that should the deck be cleared early, these men who have had night watches may not be disturbed.

* What to observe.

HAMMOCKS.

Hammocks should be fitted with three bottom and two head-stops, made of good nettle stuff and whipped. They are usually marked on the head, and when hung on the gantlines must be stopped on with the numbers downwards and inwards. The trouble of fitting hammocks so as to lace up, is well bestowed; they are not so readily soiled or worn out as those which are daily dragged to pieces with seven turns of a greasy tarry lashing. Moreover, they scrub clean in half the time, and are more quickly laced up. The spare suit should always be taken in, ready slung and stowed away. A shift can thus be made without disturbing bags, they cannot be used for deck cloths or wrappers, and the men have more space in their bags for their clothes.

In large ships, hammocks should be piped down by watches, and in bad weather the mate of the watch should look out for a clearing off so as to get them down dry.

The only way to air bedding effectually and tidily, is to stop the blankets on the gantlines by the station bill for scrubbed hammocks.

BAGS.

The best way to mark bags is with a round piece of hide sewn on the bottom with a grummet round it, and having the number cut on the hide. Bags should bear the owner's number on the ship's books, and thus go with him wherever stationed. What a cabin is to an officer, a resting-place for his bag and diddy box is to a man. The fitments on a lower or orlop deck ought to be very important that interfere with a place for the permament stowage of bags. If we take into consideration the time spent in getting bags up and down, and in chase of the owner of a stray one, who perhaps has spent the best part of his meal hour in search of it, amidst the confusion of the transit; the time spent in vexatious inquiries into pilferings occurring in consequence; the discomfort to a man arising from his inability to shift his wet clothes, or put on old or new ones, and the positive worry that all this occasions —we will think seriously before we "routine" bags twice a day up and down hatchways. Bags, as affecting the comfort or discomfort of the men, are matters

of very large importance. Men cannot work heartily in their mustering clothes. Ten minutes expended in shifting to working dress for a press of work, will be caught up before an hour is over. All that the men call *elbow-grease* is in the jumpers. If we have our bags stowed, so that we can lay hands on each particular one, we may adapt our dress to every circumstance. We shall always have good clothes for muster, good work out of working rig, and good health from timely shifts on account of weather. Mustering the liberty men with their bags before leaving, and then stowing their bags under charge until the return of their owners, are not only checks to sales, but also to theft.

CLOTHING.

"Working dress" need not be so vague a term as to admit of variety of colour and material.

The best rig is a suit of duck, made large enough for wearing over all, to be put on whilst coaling or refitting, and to be scrubbed and taken in as hammocks are.

Let the men appear in their night uniform, all blue, at evening muster; shifting at a certain period according to the season.

The dress for the day to be announced before breakfast, if possible; the forenoon watch coming to muster in that uniform.

On Sundays it is well to let the men, if in white, bring their blue frock to muster, as it frequently becomes cold during church.

A certain quantity of clothing is necessary for each man. In mustering clothes, let them parade that quantity; if they are short, take their names down for sufficient material to complete. What they may have above the establishment is of no consequence. Much time is lost at muster from noting each article specially.

WATCH QUARTER AND STATION BILL.

Ships are supplied with a table of complement, and a scheme for the quarter bill. By the latter the system for fighting is officially arranged. It is left to the option of the officer in command to dispose of his strength for the purposes of working ship, as he may think best. It is an approved method to take the table of complement for the particular rate, and from the whole com-

plement, deduct the officers, marines, idlers, stokers, and second-class boys. The remainder gives the number of men disposable for the watch bill. As the artificers and signal-men are included in the idlers' list, from the remainder take sufficient numbers for quarter-masters and boatswains' mates; and then, as an approximate for equalising the strength and giving every man stationed aloft about a fair proportion of canvass to handle, calculate thus: As the number of yards of canvass in the courses and top-sails, &c., is to the "remainder," so is the number in (say) the main-sail to the number of main-yard men, and so on.

Of course, it will be remembered that some canvass is lighter than others, and that from stay and studding-sails, fore-top men do more work aloft than the main and should therefore be equally strong. Divide the first mentioned remainder into two watches, each watch into two "halves," and each "half" into two "parts;" the odd numbers being in the first halves, the even in the second halves, beginning with number "one" in each watch. Thus we can keep two, four, or eight watches without an additional set of stations and numbers to remember, which is the case with a ship's company divided into three watches.

The first parts are usually sail loosers and furlers; the second, upper-yard men and second company of small arm men; the third parts, sail furlers, spare boats' crews, and third company of small arm men; the fourth parts, boats' crews and spare hands for duties aloft, but generally working on deck.

The first halves of the port watch wear one stripe on the left arm, and the second two. The first halves of the starboard watch wear one stripe on the right arm, and the second two.

For want of space, numbers are printed instead of words in the annexed form of watch bill, and represent these: —

No. 1. Man's number on the watch bill.
2. His number on the ship's books.
3. Quarters.
4. Boat.
5. Duty aloft; such as F. Y. F., fore-yard furler; F. Y. L.F., Fore yard loose and furl; C. L. F., Cross, loose, furl top-gallant yard.

In working ship with the watch, keep the second halves to the port duties, and the first to the starboard; they will thus all learn, and come in for an average share of work. For

FORM OF WATCH BILL.

<table>
<tr><td colspan="12">Port Watch.</td><td colspan="12">Starboard Watch.</td></tr>
<tr><td colspan="24">Fore-Castle Men.</td></tr>
<tr><td colspan="6">1st Half.</td><td colspan="6">2nd Half.</td><td colspan="6">1st Half.</td><td colspan="6">2nd Half.</td></tr>
<tr><td colspan="6">1st Part.</td><td colspan="6">2nd Part.</td><td colspan="6">1st Part.</td><td colspan="6">2nd Part.</td></tr>
<tr><td>1</td><td>Name and Rating.</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>Name and Rating.</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>Name and Rating.</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>Name and Rating.</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
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<tr><td colspan="6">3rd Part.</td><td colspan="6">4th Part.</td><td colspan="6">3rd Part.</td><td colspan="6">4th Part.</td></tr>
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</table>

instance, if on the port tack, second half of top-men aloft to set stud-sails, shake a reef out, &c. &c.; second part, furl top-gallant sails; or else let them take the aloft duties day about.

It prevents confusion to denote the watch that is, or may be, called on deck, by a board having the letter P on one side and S on the other; making the boatswain's mate or quarter-master of the last watch answerable that it is correctly fixed in some place where the watch letter may be seen. Some ships improve on this, and denote the part or half for duty aloft, or for small work on deck, by similar means.

All petty officers are supplied with lists of their men, and may be trusted to muster them during the day; but at night, the most approved practice is for the officers of watches to be called before the hour of relief, so as to be on deck in good time to muster their own watch. The men fall in on one side; one midshipman musters, another (or the ship's corporal) checks the "sick" replies with the binnacle list; the men pass across, answering their name and number, as they are called; the reliefs for the wheel, lead, looks out, life-buoy, relieving tackles, lee sheets, and halyards, &c. &c., fall in, and are inspected at the times appointed for relieving these posts. When the relieving watch is mustered it is "called," and then the other one is at liberty to go below. When the officer is satisfied with the ship's position and condition, the other is relieved of responsibility. Thus we have an entire and sober watch constantly on deck; and until a happier experience proves that squalls will not take us aback, or another ship run into us because it is "eight bells," we cannot afford to be less exacting.

The petty officers and carpenters, after having gone a round of inspection, report the ropes clear for working, the guns secure, sentries alert, life-buoy primed, the pump well right, and, if under steam, the steam-lights trimmed and the ashes disposed of.

The Royal Marines are added to the watch bill on a separate division, and the working parties are kept in equal force by taking the guard from each watch. Where there are marines enough, over and above the number necessary for great guns, it is an excellent arrangement to take that surplus for guard duty, having a change round once a month: for it often comes hard, for example, on a man who has just kept a watch in the working party to become "sentry go;" and equally so for one who has just come

off sentry to be summoned to gun drill or general quarters. The Marines generally compose the first company of small arm men.

The Idler's list is divided into two classes, the "*excused*" and "*working.*" The former are only employed, apart from their special duties, at general quarters; the latter, when idlers or all hands are called. Although it will require sharp practice on the part of the police, it is but right, when hands are on deck, to consider the particular duties performed below by some of the idlers, and to allow the servants, steward's assistants, and reliefs to go below in reasonable time.

When not standing by, we summon the whole, a half, or a part, according to the force required; thus we do not wet or disturb more hands than are necessary.

We make it generally known that "*the work must be done*" is a law to which everything must give way.

If a part work slackly, this of course shows we want more strength, and we call a half. If the slackness continue, the watch is called, and, if need be, the hands; for it is impossible in these cases to select a solitary offender for an example. Whatever may be done with the party afterwards, the immediate consequence is that the real offenders who have caused the turnout hear of it on going below, with a far more corrective effect than would be produced at the gangway.

All evolutions should be briefly, distinctly, and sharply piped. Boatswains' mates acquire, if permitted, a drowsy manner of groaning over a treble bass solo: and often the chance is lost before they have arrived at the end of the gamut.

The particular "part" of the ship, that is, the parties who are to be employed, should be named. The term "watch below" is most objectionable. Men begin to consider such a thing a right, even though in harbour with all night in and short days. The indefinite quantity "after" or "fore part of the ship" is prolific of complaints, for, when used, there will always be claimants for neutral ground.

There should be one cook of the mess in each watch, officially known daily to the master at arms; the rank being local and temporary, and never acknowledged among the watch on deck.

After every evolution ropes should be reported clear for running.

CONDUCT BOOK.

For the purposes of drill, the watch and station bill may be sufficient; but an alphabetical Conduct Book carefully and judiciously kept is almost the only source from which can be derived a correct estimate of individual character. It would relieve the first lieutenant from much uncertainty (and possibly from self reproach) and the chance of dealing unjustly with his men if as much of a man's history, occupation, antecedents, capacity, and conduct, as could be collected from his certificates, &c., together with a true record of his behaviour—good and bad—while attached to the ship, were entered under his name. Cases will arise in which are involved not only the granting or withholding of indulgence, but the issue of those certificates on which much of a man's prospects depends; and it cannot but be a great relief to a conscientious * officer to have before him a body of reliable records, from which he may infer the probability of a case perplexed by the conflict or insufficiency of evidence. † Bound as the first lieutenant is to lay before his captain the grounds on which he may arrive at a just decision, it is of great moment that he should have the means of collating the general tenor of a man's life with the particular offence charged against him. It is true that that offence may be in direct discord with antecedents—a case possible, but not likely—but still, when testimony is contradictory, inconclusive, or equivocal, he cannot go much astray if he cast the entries of the conduct book into the scale and conclude accordingly. For all these uses, the conduct book is too important a register to be entrusted entirely to the hands of a deputy. Its value consists in its thorough honesty, discrimination

* "Officers should reflect that the character of a seaman on his certificate, is his passport through life; by it he gains promotion or employment, and by it his future pension is affected."—*Admiralty Circular, No.* 131.

† The Duke of Wellington remarks;—"It is most difficult to commit any prisoner, for the soldiers have little regard for an oath; and the officers, who are sworn to try 'according to the evidence,' have too much regard to the strict letter of it. A court martial is no longer a court of honour, where a man was certain of receiving punishment *if he deserved it*, but it is a court of law, whose decision is to be formed upon the evidence of those upon whose actions it is constituted as a restraint."

To prevent misapprehension, it must be observed that this extract from the "Despatches" is only intended to illustrate the great importance which that great disciplinarian attached to discrimination.

and impartiality, and if marked invariably with those features, would be felt by the men to be an infallibility. They would bow to decisions inflicted by it, not only because the written record was there, but because that record had been inscribed by one in whose judgment they could rely, and whose high-minded fairness they could trust. The master at arms may be an upright man, but he is not far removed from the men themselves. He gets his leave in turn with the ship's company, he has his likings and dislikings, his favourites and fancies. His sense of right and wrong may be blunt and dull, or warped—unknown to himself—by low considerations; his estimate of character may be based on an undue value for some qualities, and as undue a depreciation of others; his prejudices may be more powerful than his judgment, and his temper may be of that stern nature which makes no allowance for extraordinary circumstances. All this may contribute to render the conduct-book kept by him a very imperfect, if not unfair, picture of the morale of a seaman. In the hands of the first lieutenant the case is different. From position, education, and habits, he is not likely to be tinged in his estimate by such considerations as these; he has seen his men in all circumstances, felt their natures in moments of need, marked their zeal in the hour of danger, and read them thoroughly on occasions which strip the disguises off the most artful. A record of conduct kept by such a man diligently and conscientiously, and uncoloured by the touches of a subordinate's hand, would probably be found not only one of the best aids to justice, but one of the best promoters of good conduct that an officer could command.

The right management of men is difficult under any circumstances, but specially so in such an artificial world as a ship. The interference of the executive must be constant, it must be vigorous, and to be tolerable, must be judicious. The superiority of prevention to cure is proverbial; but, as it is only the close observers who will detect the early stages of disorder, so it is only the skilful hand that can apply the efficient remedy, and only a thoughtful student of human nature who can administer it so adroitly as to make it almost imperceptible. Lord Collingwood complained in his day that "some endeavoured to conceal by great severity their own unskilfulness and want of attention, and that the men were beaten into insubordination."

The desire to rule upon principles of commingled justice and kindness, is as widely separate from unhealthy "good fellowship" as the loudest denouncers of popularity-seeking could wish. Until it can be shown satisfactorily that an officer should not study to be *fairly* popular, and that the attempt is incompatible with the good condition of a ship, it is not wrong to maintain that, although there may be all the appearances of high discipline, and faultless system from the water lines to the trucks, and from the keelson to the nettings, unless the executive be in sympathy with the men, the ship will not be "*all alive.*"

ROUTINE.

When possible, it is of course desirable to adopt a system for carrying out each day's duty; and some officers have attempted to furnish a scale by which even every minute is to be employed in the performance of a specified operation. But they have overlooked the fact that ships are to "observe the motions of their superior," and the consequence of a ship being tabulated by such routine boards is, that the people, being accustomed to do things by method, are so discomfited by a change of weather, or a sudden unexpected order, as to be utterly adrift.

The short form for routine and executive's order book, is — "Hands at . . . . A. M. Call me five minutes before that time.' A ship that has to follow motions should always be some little time ahead of the Flag ship in all her necessary internal duties; and this can only be effected by the personal vigilance and talent of the first lieutenant. If he depute the hardest of all duties, the morning ones, to the mate of the watch and the "routine" board, and comes on deck some two hours after hands have been called, in the belief that hammocks have been brought up, people have turned out, and decks have been cleaned, according to the programme, his must be a chasing ship, and consequently "behind" all day. This involves constant hurry, dissatisfaction, and indiscriminate censure; and the report of a lowering sky creates less alarm on the lower deck than the cloudy looks of the *late* lieutenant.*

In no case is the homely adage more apposite than in that of

* "Well had the boding tremblers learned to trace
The day's disaster in his morning face."

a ship; it is the eye of an early ship-keeping executive that makes her *fat.** Almost omnipresent, he discerns unerringly between those who do the work and those who do not. His activity stimulates the lazy, and encourages the active; causes for complaint do not occur; blame is not blindly dispensed; the ship will partake of the early character of her first lieutenant; be among the smartest of the smart, and keep stroke almost with the fugle man; she will stand A 1. in the estimation of the Admiral, and her crew will become too proud of themselves to allow another to eclipse them. It has been well said that "the more the Admiralty feel it requisite to curtail coercive measures, the more imperative it becomes, on the part of officers, to increase their zeal."

It is very convenient to station men for muster by Open List, forming them in hundreds. Issues and musters are thus greatly facilitated.

Mustering by Divisions is a tangle. Whereas, in that by quarters, each officer has his own men, and can inspect, not only gun gear, but personal appearance. A bugle note with the drum readily denotes whether arms are to be brought or not.

Generally speaking, when once put to rights, the forenoon watch on deck should be mustered (clean) after a three-quarters-of-an-hour's breakfast time by 7.30 A. M. at the latest; second class boys at the same time. Running the boys about the rigging *then* interferes with all their duties below, therefore they should be instantly dismissed.

Even if the lower deck be not finished, the other watch, though not "clean for muster," are in uniform colours in winter; and if the eight o'clock evolution be as heavy as those of winter generally are, you can send all hands to stations aloft. If it be summer, the difference of colour will be of no great consequence, for, most probably, the work can be performed by the "watch on deck aloft."

In some ships, the following system was found to work well:—

All breakfasting was over in the officers' messes by 8.30; the

* Nelson is reported to have frequently said "that he owed his successes to the fact of being always a quarter of an hour before his time;" and Wellington writes, "Every officer is personally responsible for the execution of the orders which he receives from his superiors, and I am responsible for the whole. It is no excuse for me, or any other officer, to state that he ordered an inferior to carry it into execution."—*Despatches*.

forenoon watch and officer of the guard breakfasting at 7.30 and relieving the deck at 8 A.M.* Great care was taken that the servants were not interfered with for ship's duties, until the general muster, which took place invariably at 9. At this hour, the ship and crew were ready for any kind of duty. The crew were mustered at quarters; this done, the bell tolled, the men came aft on their respective decks, and the chaplain read morning prayers,—this revival of the old custom of the service not occupying more than ten minutes,—the whole of the morning parade was over by 9.15, and the morning watch people had a long forenoon rest.

MEALS.

Stewards find it more convenient for themselves to issue bread about twice a week. As the barge is not large enough for such a supply, a great part is stowed in a bag and is consequently ground to powder; this bag being moreover inconvenient and unsightly in the mess places. Besides, in a new ship the raw hands eat up the supply at once, to the hardship of their less voracious messmates. The only objection to daily issue is the additional trouble to the stewards.

The issue of a large ship's dinner will take fifteen minutes. It is therefore customary in well managed ships, to order the commencement that time before piping to dinner; the cook of course not being permitted to clear the coppers until the time of dinner.

CLEANING DECKS.

The philosophy of cleaning decks consists in getting a fresh surface on them, and a wipe from a cloth with either hot or cold water does not effect this. It is the "lick" system, and the "promise" of benefit is never kept. Dumb scraping afterwards *does* carry off much dirt, but it is ruinous to the planking. The

* Inspecting the "*reliefs*" on the upper deck, *in preference to 'tween decks*, is the most certain way of having sentries clad according to weather. Whoever it may inconvenience, the men are benefited.

"puggy" condition of a lower deck can only be got rid of by stoning and ventilation.

Wet stoning can only be done occasionally, when weather is so fine that the people will rather enjoy a picnic on the upper or main deck for the day.

Dry stoning, especially if the sand is dried in the oven before use, will clear the pores of the wood of every particle that emits bad odours. It may easily be overdone, and the sweeping up so carelessly performed as to become a positive nuisance: but if merely enough sand is used, and the deck sprinkled with any vessel having a fine rose, or with wetted tea leaves, there need not be any dust.

The objections to wet decks are supported by the medical officers with such a weight of evidence, that they cannot be gainsayed; and if a mate of a deck does not think the health of the crew a matter of indifference, he may so arrange the process of cleaning as to prove that dry decks are not incompatible with comfort.*

If in all cases of "all-hand" operations, such as refitting, coaling, general exercises, &c., the decks be previously sanded, every footfall "stones" the deck, and a "rinse" or sweep down afterwards will leave the surface without a soil.

But no decks can be kept clean without a large proportion of spitting kids. If made in nests, they stow easily. The dry system has been completely tested in many ships, and found to answer well. For when the men were led to comprehend the connection between neglect of cleanly habits and 4 A.M. wet stoning, and a careful use of kids and general tidiness with an extra hour and half in bed about that time, they became as scrupulous about the decks as they would have been in their homes. Moreover, they came fresh to their work in the forenoon — a consequence worth consideration, especially in cases where perhaps, during the previous night, they had been employed for

* "His (Collingwood's) flag ship, with a crew of 800 men, was on one occasion more than one year and a half without going into port, and never had more than six on her sick list. This result was occasioned by his system of arrangement, and his attention to *dryness*, *ventilation*, &c., but above all, by the contented spirits of the sailors, who loved their commander as their protector and friend, well assured that at his hands, they would receive justice and kindness, and that of their comforts he was more jealous than of his own."—*Collingwood's Life*.

four hours, in working ship. In the ships referred to, the masts and booms were scraped on Friday, all the decks were thoroughly cleaned after an early breakfast on Saturday; and, excepting the dry rubbing on the lower deck, and a little drying up in the site of the kids, that great operation lasted for the whole of the ensuing week.

A Head Shoot is a great source of dirt. The rubbish is carried about the ship in the first instance, and frequently blown inboard in the next, to say nothing of the unsightly nature of the article in question. Large tubs are the best—one being kept on each deck. The dirt, which must be somewhere, accumulates there, and as these tubs are usually fitted with appropriate slings, they can be hoisted out from time to time with a slip whip and toggle.

The Ventilation is a subject which requires constant attention, for the violent fits of coughing and feverish symptoms exhibited by strong men when called up at night, show what a foul atmosphere on the lower deck may produce. At sea much may be done by keeping the main sail set before the wind. In harbour it is far better to make all sail in the morning, during sultry weather, than to spread awnings. Shade may be given by bracing the yards about. Pipes might be carried along the lower deck beams, which being perforated, and leading into fore and aft ones, and these again into upright ones, will disperse foul air, and circulate fresh. Gutta percha or zinc could easily be thus applied. At all events wind sails must not only be hoisted, but their mouths protected from being tied up.

SUNDAY.

The subject of the observation of the Lord's Day cannot be considered irrelevant to that of discipline, when it is recollected how strongly it is insisted on in the Articles of War, not simply as a Christian duty, but as tending to good morals and right conduct. "All commanders, captains, and officers, in, or belonging to, any of His Majesty's ships, or vessels of war, shall cause the public worship of Almighty God, according to the Liturgy of the Church of England, established by law, to be solemnly, orderly, and reverently performed, in their respective ships, and shall take care that prayers and preaching, by the

chaplains in holy orders, of the respective ships, be performed diligently, and that the Lord's Day be observed according to law."* It appears that, at one time divine service daily, was the usual custom of the British navy, and was doubtless enforced from a conviction of the salutary influence that the frequent consideration of eternal things would have on the minds of those who "occupy their business in great waters."† The resumption of this custom in many instances has proved the wisdom of the regulation. A ship's company has been found to require less punishment where the power of the Great Master's word has been felt. But in this, as in the more important services of the Sunday, all "care" should be taken to bring the men together unexhausted by previous labour, and to render the services as pointed and arresting as possible. A little management would obviate the necessity for "holy-stoning," &c., which somehow has become a part of the Sunday morning's exercise‡, and thus contribute to produce that calmness, quietness, and order which of themselves would indicate that the "First day of the Week" was something different from all the others. Probably, much of the effect that might result from a well managed Sunday service is diminished, if not neutralised, by the toil, noise, and mental distraction which precede it. It is unreasonable to expect that men will "receive with profit" religious instruction, or join heartily in prayer, who have been abruptly summoned to them, wearied in body and ruffled in mind. Of course, in such a peculiar world as a ship at sea, everything must bend to stern necessity; but without encroaching on discipline or essential duties, many things which are pronounced necessary might, by consideration and management, be avoided.

* Articles of war.

† "The commanders of H.M. ships are to take care that divine service be performed twice a day on board, according to the liturgy of the Church of England: and a sermon preached on Sundays, unless bad weather, or other extraordinary accident, prevents it."—*Naval Instructions*, A.D. 1734.

‡ The usual routine commences with an order to "prepare at 3·30 A. M. on Sunday to stone decks," and assigns a particular duty for nearly every ten minutes from 4 A. M. until, when having gone through the fatigues of decks, side, copper, paint-work, guns, arms, yards, awnings shifting, stowing, the wearied people are ordered up for church about the time that preparations are making for dinner.

CHAP. XXI.

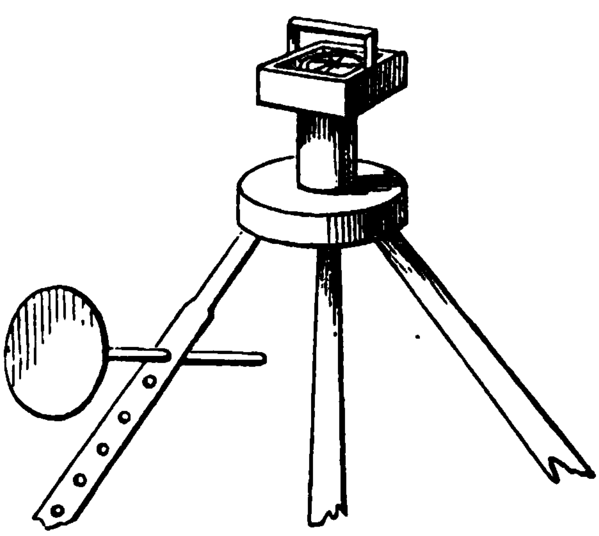
PREPARING FOR SEA.

COMPASS.

The only natural magnet known is the loadstone. Magnetised iron or steel needles will communicate their power of attraction to other pieces of similar metal. The magnetic power can also be imparted to iron and steel by holding the bar slanting in a northerly and southerly direction; the upper end being to the south and the lower to the north, resting on a block of iron; and striking the lower end smartly with a hammer. If nicely balanced, it will then swing with its lower end to the north. Two needles, each pointing north, will, if placed near each other, repel each other. If the north pole of one be brought near the south pole of another, they will attract and approach each other, as in positive and negative electricity. Iron is more readily magnetised than steel; but the former parts with its power quickly, whilst the latter remains permanent. The powers of either natural or artificial magnets may be destroyed by careless stowage, lightning or red heat. The compasses may be adjusted at moorings when the swivel is on; in a steam-ship, with the steam at slack water, the dash of the water against the rudder when hard over will carry the stern round. A cabin compass fastened to a cross head on a long spar placed upright, and read off with the spy glass, is a safe correction; and this has answered where there were no means of adjustment by swinging, for nothing in the ship can attract fifty feet above the deck. When sent for from below, a midshipman should always be able to tell the state of the wind, and how the ship's head is, as well as the bearing of any land that is in sight; not only how it bears by compass, but also how it bears from the ship's bow, if it be near her track; for there are points in the compasses of some ships which require unusual correction. A prompt answer to such questions may save a ship. Land was reported in the * * * * to bear on the lee bow; and the order given below was to haul up a certain number of points: the officer altered course *by compass*, and put the ship on the ground.

The variation of the needle is caused partly by the large masses of iron which are on board a ship. Mr. Barlow discovered that the magnetic power resides entirely on the surface of a body, and is independent of it as a mere mass; so that a hollow globe of iron has as much attractive force as a solid of the same diameter. Hence as the disturbing causes are ahead of a ship's compass, Mr. Barlow thought of arranging a certain amount of metal behind it, which would compensate, or nullify, the effect of local attraction. The correcting plate is composed of two thin circular plates of iron, 12 inches in breadth, and kept from contact by a circular piece of card or board. This plate is attached to the compass stand by means of a brass or copper rod.* The manner of using this apparatus is as follows: — When a ship has completed her stores, the variation of her compass is noted as her head is swung round all points of the compass by a comparison (conducted with signals), with another compass on the land. The ship's compass and stand are then taken on shore, and placed free from all metallic attraction. The object then is so to adjust the plate as to produce the same deviations in the ship's compass at each movement of the compass box as were occasioned by the local attraction of the ship. This done, the distance from the centre of the plate to the pivot on which the needle turns is carefully noted, together with the angle which the plate makes with a vertical plane.

Fig. 210.



When the plate is used on board, it is fixed (as in *fig.* 210.) to one of the legs of the standard compass tripod, which compass must stand in its former position, at the same distance from the centre of the needle, and at the same angle with the vertical as when used on shore. The plate having been made (when on shore) to produce as much error as all the iron on board, the error is now consequently doubled, and allowance either increasing or diminishing, is applied accordingly.

* Nautical Magazine.

STEERING GEAR.

Ships are fitted with either a *Tiller* or *Yoke*, according to the amount of space abaft the screw chamber. All sailing ships have tillers.

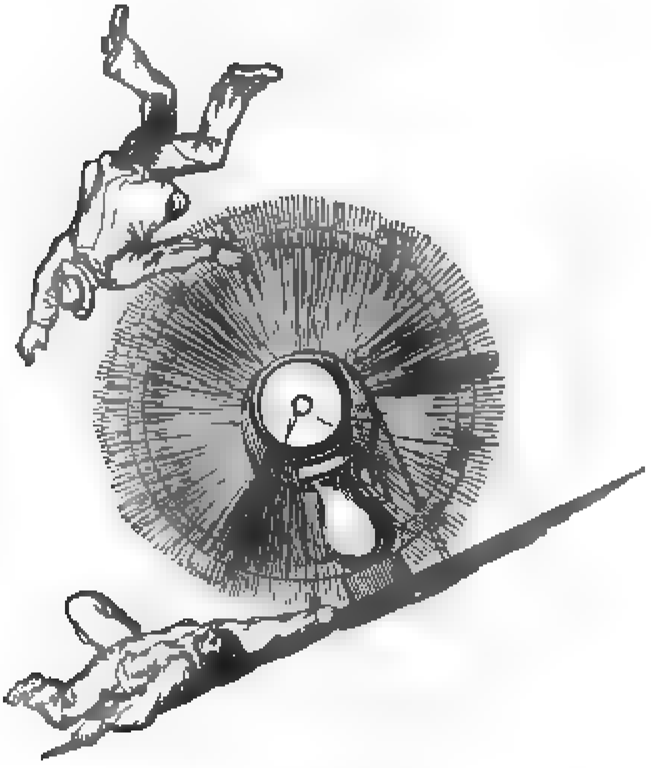
The arrangement of tiller ropes is the same in either case. A single block is seized on each side of the foremost end of the tiller, the ropes pass through a series of leads to the sides; from thence through the tiller blocks, and back to the side, where the ends are secured; in the case of very short tillers or yokes, the parts below being trebled.

In very bad weather, tackles are put on in addition, to relieve the tiller ropes, and the men who work them are communicated with, from the binnacle, by means of a tube.

Yokes are generally formed with two metal sheaves at each end.

The *wheel* is fitted with "twiddling lines;" these are made fast to the lower part of the stanchion, and are intended to secure the wheel with when at anchor, or during sternway. They should be

Fig. 211.



passed the moment the ship loses way ; for fatal accidents have happened by the neglect of ignorant men, who have been suddenly thrown violently over the wheel, when it revolved by the action of the water on the rudder as the ship gathered sternway. (*Fig.* 211.)

PAINT WORK.

The white streak on the side is on an average about three feet wide ; and the length of the ship being known, you can tell at a glance, very nearly the number of superficial yards on the whole side.

White 28 lbs., litharge 1 lb., linseed oil 6 pints, spirits of turpentine 2 pints, will paint about 100 superficial yards.

Black 28 lbs., litharge 1 lb., linseed oil 10 pints, turps 2 pints, will paint 160 superficial yards.

Black 46 lbs., litharge 2 lbs., boiled linseed oil 3½ gallons, will paint hammock and hatchway covers, seamen's bags, 100 yards running measure.

White 21 lbs., yellow spruce 7 lbs., Venetian red 1 lb., linseed oil 1 gallon, will give large lower masts one coat of spar colour.

1 lb. of black when thinned will cover about 6 superficial yards once ; this does for spars, "touching up," &c.

All knots should be "killed" before painting, otherwise the turpentine will exude. Cover them with fresh slaked lime for twenty-four hours, then scrape the lime off, and lay on a coat of stiff red and white lead, mixed with glue size. Pumice stone when dry, and then lay on some paint.

Zinc paint is very much preferable to white lead for "'tween-decks ;" as it is not easily discoloured by foul air. Care must be taken not to use with it litharge, or any article based on lead, as a "dryer :" the proper kind can be purchased at any colorist's along with the paint.

LIFE BUOYS.

Hulks are not fitted with life buoys ; therefore the ships are drawn and fitted at once. The words "pull" and "fire" are painted, the former in white, the latter in red, immediately over each handle ; their duties and localities are thus soon generally known.

NIGHT SIGNALS.

H.M. ships, when under steam, are required to carry a Bright light at the fore-mast head, a Green light on the starboard side, a Red light on the port side.

The coloured lights are fitted with a wooden screen on the inboard side, in order to prevent both from being seen at the same moment from any direction but that of right ahead; thus, in any situation in which two vessels may approach each other in the dark, the coloured lights will instantly indicate to both the relative course of each; that is, each will know whether the other is approaching directly, or crossing the bows, either to Starboard or to Port.

This system of night signals has been adopted by the British merchant service, as well as by most foreign maritime nations.

Trifles often aid memory, especially in a flurry, and where the choice lies between but two courses :—Port (wine) is Red.

All Her Majesty's sailing vessels, when under sail or being towed, approaching or being approached by any other vessel or vessels, are to show between sunset and sunrise a bright light in such a position as can be best seen by such vessel or vessels, and in sufficient time to avoid collision.

All sailing vessels at anchor in roadsteads or fairways, are to exhibit, between sunset and sunrise, a constant bright light at the mast-head; except within harbours or other places, where regulations for other lights for ships are legally established.

RULE OF THE ROAD.

The rule of the road at sea is—

That steamers pass each other in day time on the port side of each other; that is leaving each other on the port hand.

That ships on the starboard tack keep their wind, others give way.

That ships running give way to those on a wind.

That the night signal for the starboard tack is, two lights vertical on lee cat-head, and one light vertical on weather cat-head; and that for the port tack is, two lights vertical on weather cat-head, and one light vertical on lee cat-head.

That the fog signal for starboard tack is horns and drums, and for the port tack, bells.

INSPECTION.

Supposing the ship to be "complete," it is usual to see that the following matters have been attended to, preparatory to leaving harbour. The warrant officers will have "indented," that is, they will have compared their warrants, or lists of stores with the accounts in the store-keeper's office, receiving receipts for harbour use articles, and giving their signatures for sea stores.

The hulk cleaned and taken charge of by the officer of the ordinary.

The port order book returned.

Port edges lined, Port Bars, Scuttles, Scuttle handles, Hawse Plugs, Bucklers, Pumps, Fire Engine Hoses, Capstan Bars, Jack in the Box, Dead Lights, Scupper Flaps and Plugs, Winch Handles, Hose Wrenches, Port Lanyards and Tackles, Shot Plugs, Orlop marked under corresponding lower-deck ports, Swifters, Gratings, and Hatchway Tarpaulins, all in their places; Pump Handles, Sounding Rods ready for use; Trim observed, and all Empty Casks, Cases, and Shakes returned.

Also Signal Books corrected; Flags, and Signal Lanthorn yard fitted; Signal Lanthorns and Steam Lights trimmed; Signal Rockets, Blue Lights, Port Fires, Flash Pan, and Ammunition at hand.

Also Masts upright, well stayed and greased; Pendants stopt taut in; Yards square; Lifts marked; Heels of Booms square and toggled; Ends equally rigged out; Gaskets black and at equal distances; Ropes coiled down clear on deck for running, and flat in the tops; New Topsail Halyards well hauled on and re-rove, else they are sure to be cable-layed when making sail; Topsail Sheets stopt together; Lower buntlines rounded up; Hawsers reeled up, ends becketed, and each warp assigned to particular parts of the ship; Dry stoppers at all the belaying places; Spare Sails, Yards, Parrels, Brace Blocks, Awnings, Wind Sails, Boat's Covers, Mast and Yard Covers, Hammock Gantlines, Clothes' Lines fitted.

Stern Ladders, Lower Boom, and Quarter, and Slack ropes, should be hauled in. Ends of "Gangers" are apt to be let go when slipping moorings, and should be hauled in afterwards.

Also Lead Lines (Hand and Deep), Spare Wheel Ropes, Relieving Tackles, Spare Tiller, and Key head, Binnacle and Steam

Lamps trimmed ; Wheel ropes clear in the Gun-room and passages ; Log lines, Twiddling lines, Breast ropes, Man ropes, Boat ropes ready ; Life Buoy primed ; Rudder Pendants stopt up within reach ; Rudder Chocks at hand ; Anchors clear for letting go ; Buoy ropes on ; Cables clear for running ; Compressor tackles, Rigging, Bitt and Ring stoppers, Chain slip, Nippers, Punches, Pellets, Spare Shackles, Messenger, Mooring Swivel, Hook Ropes, Chain Hooks, Axes, in their places.

Also Boats square in the slings, fenders in, and rowlocks shipped ; Slips on the Gripes ; Boat Ropes of quarter boats stopped along outside all ; Falls clear for lowering, complete in Sails, Masts, Yards, Oars, Boat-hooks, Flag Staff, Rudders with Lanyards, Fenders, Anchors, Cables, Flags, Baler, Breakers, Bungs, Handy Billies, Tool Boxes, Quarter Case (containing Pistol, Flash Pan, Caps, Powder, Blue Lights, Rocket, the Staff being tacked under the Gunnel), Bowsprits and Irons, Slings, Windlass and Bars, Pipes for bottoms (if so fitted), Awnings and Stanchions, Recall and General Signal board ; Boom Boats griped ; Boat's Binnacles, Magazines and Armament complete.

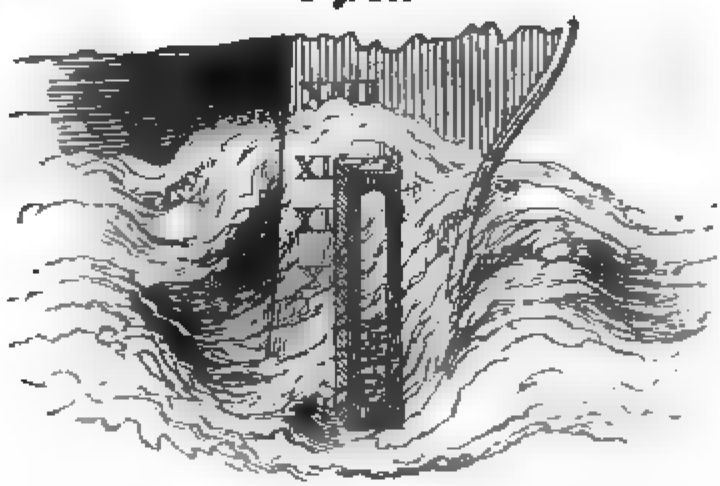
Also Guns, square on the ports, or secure for sea ; Tompions in ; Ports square ; Linch pins home ; Forelocks twisted ; Breechings clenched ; Spans fitted ; Priming Wires, Vent Bits, Locks, Aprons, Trigger lines, Tube boxes, Chalk pocket, Range boards, Tangents, Disparts, Beds, Quoins, Handspikes, Dismounting gear, Fuse wrenches, Fire buckets and Lanyards, Wads, Inclined planes, Hammer, Spike and Mallet Swabs, Converging lines, Fighting lanthorns trimmed, Shot nets, Shell whips, Fire screens, Arms, Spare Tackles, Trucks, Tomahawks, Sponges, Rammers, and Worms on each deck ; Light room lamps trimmed ; Magazine keys tallied ; Water in the Magazine cistern ; Case Shot boxes lashed ; Sweep pieces fitted ; Small Arms assorted and marked.

The Ship's Trim can be taken in harbour, even when the surface water is broken, by means of a wooden tube, open at each end and having a glass pane in one side ; the water will rise in this to a still level, and its height may be thus observed. (*Fig.* 212.)

These things and many more must be well looked to before making the first start. Happily the mere harbour order, which once obtained to the extent of unreeving rope, unhooking bowsprit shrouds, hiding necessary gear in the tiers, and then making a display of brazen and gilded finery, which involved

every sailor in a hat full of greasy brass rags, has become obsolete. Nothing that is needful is now considered unsightly; and even in "providing stores," a man has to use his eyes and common sense, rather than tax his memory.

Fig. 212.



LOOSING SAILS.

Haul lower buntlines up before letting fall courses, and make the loosers get off the foot ropes before letting fall upper sails, so that the sails may be hoisted and sheeted home in one motion.

Some officers prefer making and shortening all sail at once; but in this case, for a time the deck of the smartest ship is crowded and confused; and be the master or pilot ever so urgent, nothing can be done until the decks are cleared up. A smaller evolution, well pronounced, and sharply done is more effective than a greater one, which is necessarily somewhat ragged and confusing.

The harbour moorings are taken in by a lump which is placed under the bows for that purpose, the ship being meanwhile secured by slip ropes.

In making sail, it is considered best not to let fall the upper sails until the topsail yards are nearly at the mast heads.

In loosing sails it is not necessary that the top-mast studding sail booms should be triced up; and if the outer gaskets on the lower yards are cast off, the men who have done so may come in out of the way of the topsail sheets, as the booms will keep the sail up until the bunt is let fall.

New sails will not sheet home, and must be exactly middled.

Foot ropes of top-gallant yards are apt in hoisting to catch under the fore part of the topmast caps.

Sea gaskets, if on the yards, should be "cheesed" up, and hung square and equidistant over the fore part of the sails. See the colours clear, ports square and free from loungers and wet clothes. In short, tidy the ship up, so that in leaving harbour, from the water line to the trucks, criticism may be defied, and every one concerned be as proud of her, as if the romance of sea life was not about to be buried in the coal bunkers.

CHAP. XXII.

HANDLING BOATS.

Harbour boats are of the regular service dimensions; therefore, with the aid of the tables, we may select the quantity our boat will carry.

H. M. ships are divided into Rates, a term which refers to their number of men and guns; and again into classes, a term having reference to their size. For instance, the "Queen" is a first class, first rate. The "Royal George" was a first rate, but of the third class. There is a certain proportion of stores of each kind allotted to every ship according to her class and rate, and which, when drawn, come under the charge of the Boatswain, Gunner, and Carpenter. These stores are particularly specified in books called "Warrants," one of which, containing a catalogue of the stores which concern him, is supplied to each of these officers.

When about to draw stores, the warrant is taken to the issue store, and the clerk, as he issues, checks the articles off. Anything which is not "on the establishment" must be specially applied for in writing to the commander-in-chief; and on applying in due time at the store-keeper's office, if the demand be approved, it is added to the warrant and then supplied.

When sent to draw stores, an officer should consult the tables of the capacity of boats and weights of articles, remembering that harbour boats are of similar capacities with those supplied for sea service. Neglecting this, an officer may draw too few or too many stores. If this happen near to noon, at which time the

store houses close, there is no time to rectify the mistake. In the former case, an extra trip must be made; in the latter, some one belonging to the boat must remain dinnerless in charge of the surplus.

Be careful with oars, their blades being easily ruined by throwing them on the stones. Keep all the casks "bung up." See that tar casks (which stow generally in the hot fore hold of steam ships) are not quite full. Have tarpaulins for covering bread. Sling the midship casks as they are stowed; put the rum casks in last, and *never lose sight* of them until they are out of your charge.

If in a tide way, do not forget what may be done with a warp.

When ordered on boat-duty, it is well to remember your men's meal hours, either taking the provisions in the boat, or warning the master-at-arms that the crew will be absent. See that the gear — masts, sails, oars, fenders, boat-hooks, baler, anchor and cable, painter, flags, breakers, water, rudder, awning, and stanchions — is complete, and that the crew are properly dressed. It has been found very convenient to keep a quarter-case in each boat, containing a pistol, flash-pan, powder, caps, a rocket and blue light, hatchet, and a few nails, &c.

A boat officer is always supposed to have his spy-glass, watch, and signal-book at hand; and it is well to make certain that orders are rightly comprehended before leaving the ship.

If about to sail, get the sails taut up before shoving off; see that the yards are slung, so as to set the sail smoothly. Ship the rowlocks; make all the men who are not about to spring the boat off, sit down; haul up; sheer off; in fenders. As a general rule in sailing, insist upon the crew sitting down on the bottom boards of the boat.

The hauling end of lug halyards is always long enough for a downhaul. Splice an eye in its bare end, and put this eye over the hook of the traveller before hoisting.

Keep your weights amidships, and never belay the sheets.

Before reefing on a wind, tell the men off for the different duties; the two bowmen to gather down on the luff; two weather hands by the halyards and downhaul; the lee hands to tie the points; one strokesman to attend the sheet, the other to assist the coxswain in reefing the mizen. No person need stand up. Neat two-handed boatmen never jump about on the

thwarts, or show more than their heads above the gunwale. Do not luff up; check the sheets; lower enough to shift the tack hooks easily; gather the fore-sheet aft, that the men may reach the foot of the sail without leaning over the lee gunwale; shift the sheet; tie away; slack the sheet; hoist; resume places, and haul aft. Should the mizen be reefed more quickly than the foresail, do not haul its sheet aft until the boat has steerage way on, else she will get in the wind, and lose time.

There is another way of doing all this. The officer steps into his boat without a clear understanding of orders, or the least consideration for his crew. "Shove off;" "Hoist away." Everybody stands up or sits on the gunwale, and "carries on;" the mizen is up first; the boat comes nearly head to wind, and goes chopping astern; the officer puts the tiller the wrong way; the foresail is hoisted all aback, and the boat tilted over to windward. Some one who has got an oar out on that side to pull her head round, "catches a crab;" she comes round; the sail binds against the mast, and will not come down; there is no downhaul; and if not upset, the crew contrive to gather the sail into the boat by hand. At length, her head is pointed the right way; the sails are hoisted, and the sheets are hauled aft simultaneously, and are of course badly set. So much lee-way has been made, that it is not possible to weather the nearest ship; and if there is not a "run-foul," the boat bears up, and runs further to leeward, or else the sails are lowered, and the oars are got out.

At length they get away under sail. It freshens; the officer has got a foolish notion that is proper to "crack on," and, moreover, he has a "water-proof," and can afford to be indifferent about wetting his men. The boat is dragging on her side, the crew are sitting on the thwarts, and much more lee-way is made than if the boat was more upright; at length a reef is ordered without any preparation. All hands stand up, and snatch at the foot of the sail over the lee gunwale, and the nominal officer resigns his command to that cherub, whose particular duty it is to "look out" for the natural consequences.

In boom boats, set the jib before setting the foresail; taking care to have the runners hand taut before hoisting. The jib is the forestay; and if the foresail be set first, the mast-head is dragged aft, and the after-leech hangs slack. If obliged to set

the jib after the foresail, ease the fore-sheet off whilst hoisting the jib, and let the mast-head go forward into its place.

In coming alongside lay the fenders out and get the bowsprit in in good time, especially if it be an iron one. The general rule is to keep the main yard of the ship end on; but that must depend on tideway, and whether the boat is heavily or lightly laden.

The boat should be baled out, slings hooked, and otherwise prepared for hoisting, before reaching the ship.

If your men are all sitting to windward in a breeze, make them occupy their proper places amidships, before passing to leeward of a vessel. There is not only an eddy wind under the stern of a ship that is riding head to wind, but also frequently an indraught of water. And it is not uncommon to see an inexperienced young officer trying to pass close under the stern, suddenly taken aback, and his mast-head, which at one moment was looking quite clear of the boom, thrown to windward and entangled by it. (*Fig.* 213.)

Hailing or interchanging hails with the gun-room, on passing astern, is just as improper as the above course is foolish.

When the wind fails, get out oars at once.

The remarks about handling ship apply equally to a boat. You may bring her to such nicety of trim under sail, that in moderately smooth water she will go round without any assistance.

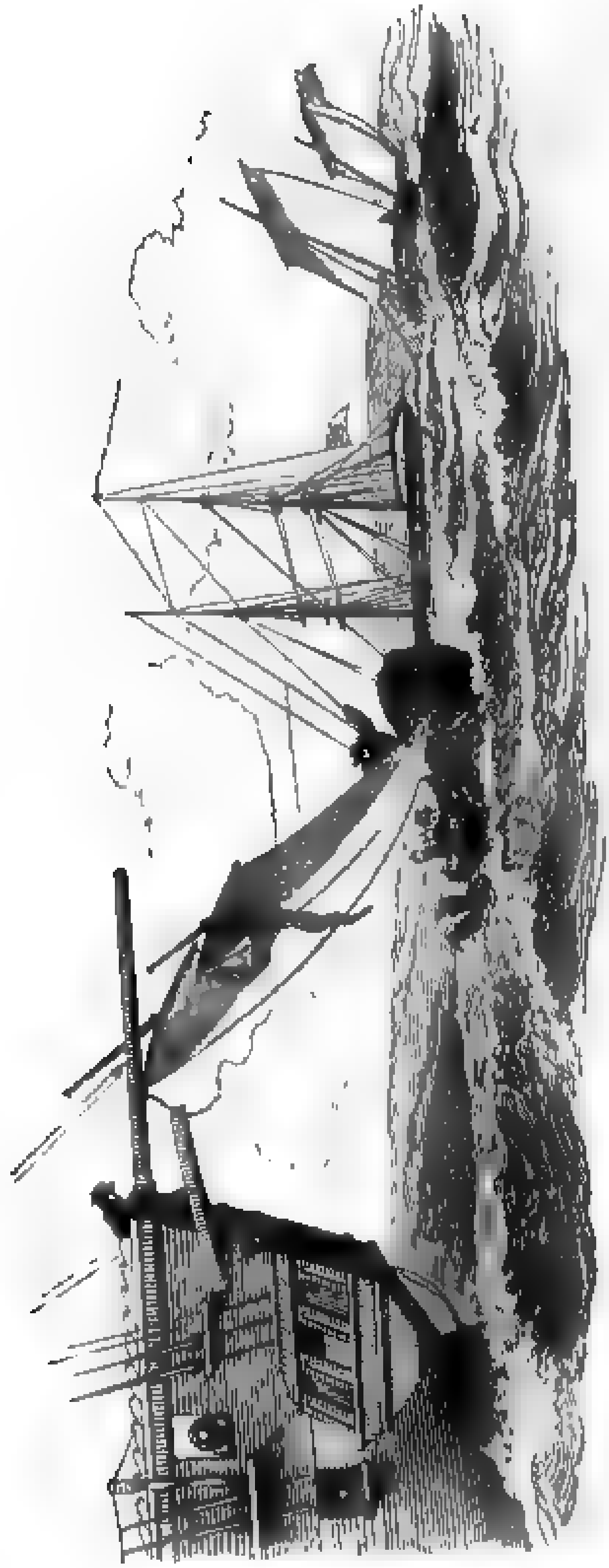
Putting the rudder right across the stern deadens the way; 42° is considered the extreme of efficiency.

When there is no way on, or when the boat is tied by the stern — as in towing, when the tow-line is fast to the wrong place, as the stern ring bolt, — the rudder has no effect whatever.

If your boat hangs in stays, and has just lost, or is about to lose, her way, you may (possibly) get her head round by a jerk of the tiller, but it looks very silly to be going through the motions of steering when there is no way on.

During sternway, the rudder has a different effect to what it has when there is headway. If when going ahead, you were to unship the rudder, and could point the stem, say three points on either bow, the bow would glance off in the direction towards which the stem pointed. It is precisely so with the rudder in sternway. If the helm is put a-starboard, the rudder points out on the port quarter, the water presses on the starboard side of

Fig. 213.



the tow line over the quarter on that side to which you desire to turn, for the helm will be of little or no use.

In towing short round, do not attempt to turn before your leaders are round.

The heaviest boats should always be nearest the tow.

Boats will tow with increased effect if weighted with shot. A few lengths of stream chain is the quickest weight that can be passed in and out, besides being less damaging to the boat.

Taking another boat in tow without delaying the duty by fouling her oars, or getting athwart ships, is a very neat performance for a young officer, and when well done betokens judgment and skill.

SALUTING.

As to saluting, the order "be courteous" requires that there should be a mutual recognition or an interchange of salute between all officers wearing uniform, inclusive of foreign, on meeting or passing each other; but, at all events, junior officers should give honour to whom it is due, without waiting to be recognised or questioning about results.

In a boat under sail (if near) pass to leeward of your superior, and never cross his bows.

In all cases the officer should stand up whilst making his salute. If the superior be of great rank (such as an admiral, &c.), the men also should rise and uncover.

Lowering the sail is not required.

In rowing, toss oars, and let the crew stand up, whilst an admiral passes.

Toss the oars to a captain or commander.

Lay on oars to a lieutenant, &c.

When oars are tossed, the blades should stand fore and aft. When "laid," the blades should be horizontal and in a line.

At the word "down" the blades should fall together flat on the water; the loom being tilted, so as not to strike the gunwale.

Boats towing or laden do not salute; the coxswain and officer do so.

BOATS DETACHED.

Make due allowance for the rate at which the tide is going past the ship, or the rate at which she may be moving, when making for her. A current frequently sets close along shore in

the opposite direction to the one that is going by the ship; and therefore, a little judgment may save a long pull. At Spithead, for instance, when the ship is swung at ebb, with her head to the eastward, the tide will run strong towards that direction along Southsea Beach, and a boat pulling straight for the ship from the harbour would be carried very much astern; whereas by dropping down with the tide, close along Southsea Beach, until well ahead of the ship, very little effort will carry the boat on board. An inquiring boat-officer will learn more of the theory of local tides and currents by a chat with a waterman, than can be found in books; and by observing—when abroad—the manœuvres of native boatmen, much labour and risk will be avoided.

When watering with casks, keep slings on those which stow amidships. Keep the end of the Suction hose in a washing tub, or place a piece of bread-bag stuff round the rose; for a very little gravel drawn into the valves will delay the work. Do not forget the engine wrenches and bungs.

When watering in bulk, wash the boat well out the first thing, and when being towed off, do not allow boat-keepers to sit smoking on the gunwale forgetting to spit overboard.

A forty-two foot launch will carry in bulk in smooth water about 22 tons of water.

In rafting casks, knock the inner hoop off each end, and drive them on over a hide or sennit becket. Stop the raft line to these beckets, but do not reeve it.

In the entire absence of usual resources, great weights, such as a gun, for instance, may be got into a boat where there is a rise and fall, by filling the boat at low water with dunnage or sand, banking up an inclined plane with shingle, rolling the gun into the boat, clearing out the sand, and waiting for the tide to float her off.

When boats are riding at the booms, the best stern fast is a whip from the main-yard with a light inhaul.

Boats may be kept clear of the ship when riding astern by causing them to tow a grating, or bucket, or net full of shot.

If it comes on to blow when you are detached, you will most probably be signalled to remain where you are till it moderates. If you return, either round to ahead, down masts, out oars and drop down; or else, if you have confidence, shoot up under the stern.

Meeting on opposite tacks, the boat on the port tack passes to leeward. Boats, &c., running give way to those on a wind. Never stretch the head of your sails in bending them, put them to the yards and gaffs barely hand taut.

In shoving off when the ship is not head to wind, pull well clear of her before making sail.

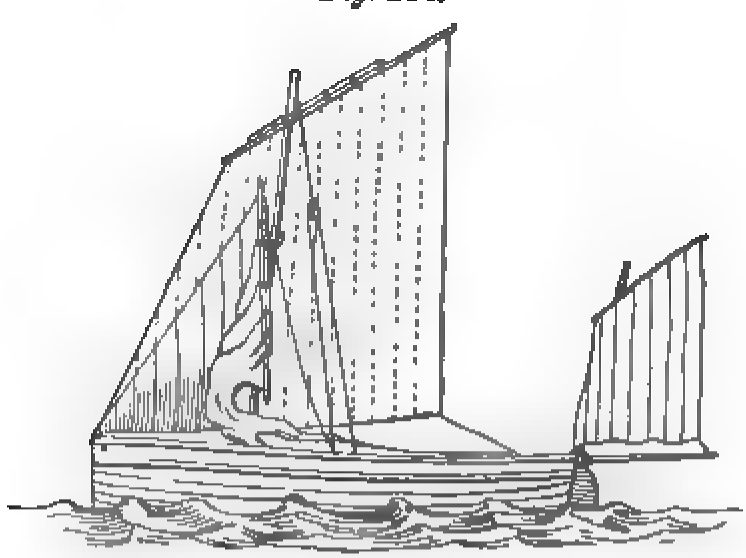
Remember in running that you cannot carry all the canvas on a wind that you can before it; therefore make ready for rounding to.

Running with much sail dead before it in a gig is very dangerous: if the wind comes a little on the sheet quarter (say starboard), it is safest to haul up to port; and when the wind is on the port quarter, haul in the sheet, lower, shift the sail round, resume course, and hoist on the port side.

When you want a pull on the halyards, let go the sheet; if in the fore, check the mizen at same time.

Dipping a lug is the neatest handed affair a boatman has to do. You must tell the men off; the bowmen to bear the fore part of the sail out, the two next to gather the sheet of the sail forward and pass it round, the after hands to unhook and hook the sheet, the others to sit fast, shifting the halyards and handing the foot along, and hoisting when ready. Do not lower until the

Fig. 214.



fore part of the sail has been aback sufficiently to bring the wind on the other bow, unless it is smooth and you have great way on;

but the sheet may be unhooked the moment the sail lifts. Keep your halyards with a mark, so as not to lower the yard more than is necessary for dipping the after yard arm ; you will have more back sail to carry you round, and less slack sail on top of your men. Attend the mizen sheet in case the boat should "come to" whilst re-hoisting fore-sail.

HOOKING ON FOR HOISTING.

When there are eyes in the tackles of quarter boats and hooks in the "slings," the thwarts and boat keepers are not fished out of the boat. When it is hooked, the keepers should hold the block taut up by the standing part of the fall; the steadying lines are secured to eyebolts in the gunwale. When the ship is scending and rolling, you should cross the life lines, and have hook ropes fast to the slings from the ship through the ports well attended, so as to bind the boat as she rises to the side; the lower deck ports should be either lowered or triced back. Send all your crew except four at the most out of the boat, make them go up by the chain ladders, and not on the life lines. When the boat is up, pass the bight of the life line through the slings over the davit end twice, and hitch before attempting to belay the fall. Pass the gripes round the boat clear of turns. Have squaring marks put on the falls, so that she may always sit square on the davits. Ship the rowlocks and rudder. If there be no scuttle which opens of itself, take the plug out the moment the boat leaves the water. Send the end of your cable and make it fast as far forward as possible outside all, and stop it up to the chains with a cut yarn. In hooking on, hook the foremost tackle first, and on being lowered unhook the after one first. In a tide way, or when there is way on the ship, dangerous accidents may happen from inattention to such precaution. See that your fenders are in, fill your water breaker, and if the weather be hot, put the cover on square and smooth during the day, taking it off at night.

In a stern boat in a tide way, or ship going ahead, do not attempt to haul across the stern or hook the stern tackle, until all is ready on deck, and then hold hard by the life lines, for the boat will suddenly fly forward.

In blowing weather or heavy tides, if a small hawser be carried round the ship outside all,—the bight being made fast to the bowsprit cap, suspended on both sides from each lower yard-arm and spanker boom end by whips with bowline knots and the ends reaching the water astern, —boats may not fear to make for the ship anywhere without running against her ; for whilst the hawser is out of the gangways triced up when not in use, the quarter-master of the watch can drop it on top of a boat, and avoid the frequently too late cry for a boat rope.

Wet warps require careful seizings. Whilst hauling ships about the harbour we never see the warps laid out by the dock-yard riggers (however wet), slip or come adrift. Their plan is worth notice. They make four parts of their spun yarn seizing, take a round turn with the bight of this round the standing part of the hawsers, then pass the seizing (figure of eight fashion) round the hitched end and standing part, then cross it opposite ways with two parts each way, reeve the ends through the bights and drag all the turns taut.

A quick way to preserve warps or small cables from injury is to reeve them through your spare gun trucks, clapping a "bear a hand" mowsing on each side.

Boats should have their particular recall, the general recall, their distinguishing pendant, a "pull to starboard" pendant, a "pull to port" pendant, the "answering" pendant, and a "you go very well" pendant, painted on a board fastened on their inside in some safe place. Boats may be manœuvred with much effect with these few "general signals."

Before going alongside a vessel under weigh, observe if she have head or sternway, and in any case get the masts down before closing her ; otherwise, if the bowman fail to catch hold, and the mast head be fouled, a capsise is nearly a certainty.

A metal crutch fitted to each boat to ship on the stern, so as to steer with an oar when the rudder is wanting, is a most useful "stand-by."

Numerous rope ladders facilitate boat work materially : stern and quarter ones are indispensable.

Having quarter and stern boats' tackles kept overhauled down in the absence of the boats, prevents delay in hoisting, dispenses with an unsightly pile of gear in the mizen chains,

and is a great saving of men's clothes, who otherwise must soil a suit in stopping up.

The quarter tackles may be becketed to eye bolts in the bends, keeping clear of port edges, else they chafe; and the stern tackles to the rudder bolts.

In being towed by a vessel, if alongside, contrive to have the rope from as far forward as possible, so as to avoid riding at a short stay: never make it fast, but toggle it with a stretcher through the aftermost of the foremost sling bolts, so as to be able to slip in an instant. Steady it near the stem with the bight of the lazy painter passed over it.

If being towed astern, the closer the better. And when about to be cast off, either be dropped astern clear of other boats, or be handy with your oars, so as to shoot out clear of other boats which may be in tow.

Do not permit other boats to hang on by your boat. If other ropes are not supplied, get more of your own towline, and after securing its bight, as before said, pass its end aft; and if it is not long enough, bend the nearest boat's warp on to it, otherwise your stern or stem will be dragged out.

The quick way to run a short warp out, is for one boat to run away with the end, and the others to pull in fore and aft under the bights as they are payed out at equal distances according to the length of the warp and number of boats, giving way the moment they have got hold.

In all cases, when you take in the end of a warp, coil enough of it forward, so as to be able to make a bend the instant your boat reaches the place you wish to make fast to.

It is hardly possible to lay a heavy warp out without floating its bight. If there is a chance of its being suddenly tautened, hang it outside the boat, instead of laying it fore and aft amidships.

In running warps out, the whole warp is sometimes coiled in the boat, and the end being made fast to some desirable place, the boat makes for the ship; in other cases, a part only is coiled in the boat, and she carries the warp from the ship to the place to which it is to be secured. Whichever way it be, there is great judgment required in reserving a sufficiency of hawser in the boat to ensure that she will reach her destination, only paying

out when certain of doing so. It is from this necessity for judging the distance by the eye, that we have the term "guess warp."

Stern boats are best fitted when they have runners as well as tackles, the runners being passed after the boat is hoisted up by the tackles. The tackles are then unhooked, and the boat is lowered by the runners.*

All standing parts of gripes of outside boats should be fitted with slips, the falls kept in separate racks, and one boat's binnacle, at least, kept on deck ready for use.

CHAP. XXIII.

ANCHORING.

SHIPS on being discovered within signal distance of the senior officer are required to show their number, and on this being recognised, that officer gives the ship her pendants; and although a fresh ship may try to reply with the answering pendant, he will not be satisfied until the pendants be repeated by the ship herself, as an evidence of a clear understanding. In this case of signalling the answering pendant is not used. There are other signals which, if replied to by the pendant, would also imply inexperience.

Local signals, or temporary additions to the signal books, general orders, and copies of the pendant board and squadron routine, should be procured without delay after joining company.

If ordered to anchor on a certain bearing, it is intended that the ship to which the signal is made, is to bear, when anchored, in that direction from the ship making the signal; and if with

* No mechanical contrivance can or does excel a simple well handled runner for lowering boats. There is no complication in a clear rope's end and a large round thimble, and this is all that is required for dropping a boat at full *speed.*

open hawse to a certain point, it is to be understood that the anchors are to be laid out at right angles to that point.

MOORING.

It must not be supposed that merely letting go two anchors, as in mooring, makes a ship safer. What then is the reason for doing so ?

If a ship let go her single anchor (say in twelve fathoms) in the very centre of a harbour which we will call about two hundred fathoms wide, and steep to all round, and then veered one hundred fathoms of cable, she would occupy every part of the harbour, as the wind or current happened to move her.

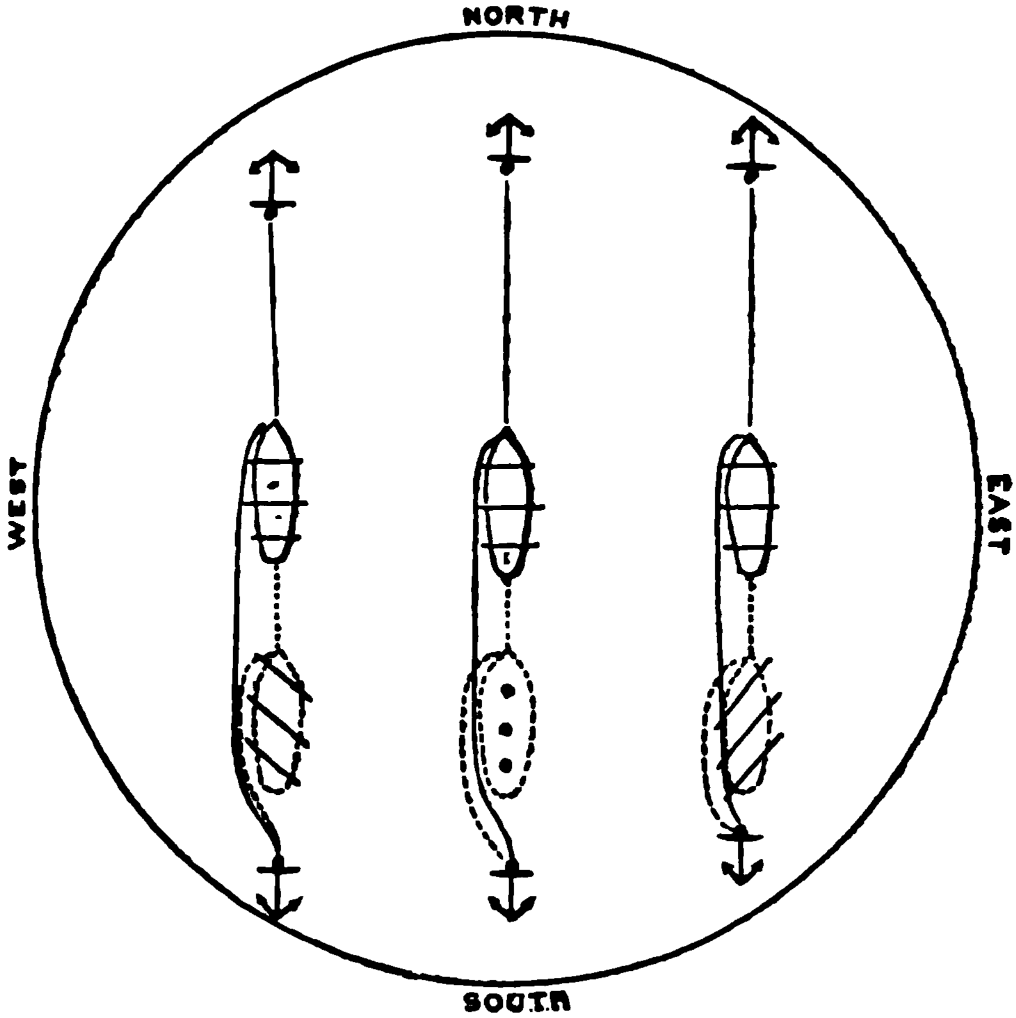
If it be desired to keep her stationary in the centre, shortening the cable into twelve fathoms would not effect it, for the first puff of wind would cause her to start her anchor.

But let us ascertain from what quarter the prevailing heaviest winds blow ; weigh, haul over, and let go an anchor in that direction one hundred fathoms from the centre : then with a warp haul the ship over in the very opposite direction, veering the cable two hundred fathoms from the last position, and then let go the second anchor. Now heave in one hundred fathoms of the first cable, veering one hundred on the last, and we shall have got the ship moored in a stationary position in the centre of the harbour ; and many other ships (suppose one on each side) may share the harbour by similar means, as shown by the full lined ships in *fig.* 215.

Whether we moor with a whole, or merely half a cable each way, or lay the anchors out in any direction (so long as they are in opposite ones, and one cable is moderately taut before we let go the second anchor) is of no consequence as far as concerns the principle we are considering.

Now with regard to the direction. Say that the prevailing gales are northerly, and one comes on from that quarter so heavy that we should veer cable. If the other ships have attended properly to this contingency, all may veer simultaneously without fouling each other, and the riding cable of each ship will grow straight to their weather anchors : in other words, they will all have open berths and open hawse, as shown by the dotted line ships in *fig.* 215.

Fig. 215.



It is clear that with a long scope of cable, we have all the additional weight of the chain in our favour, that the ship's bows are less dragged downwards than at a short stay, and the pull on the anchor being horizontal, the palm bites all the harder. When we wish to make the best use of our power, we must get as close to the resistance as possible. We do not want to move the anchor; and some officers prefer veering even as much as two cables on end to letting go other anchors. The weathermost ship in the sketch is at a "short stay:" she is displacing great quantities of water, sustaining proportionate shocks, shipping heavy seas, straining her cable, and breaking her anchor out of the ground. (*Fig.* 216.)

Now suppose that one or both of the other ships had moored without regard to the position of our anchors and the direction of the prevailing gales. As long as the weather was fine, and we did not want to move, it would be of no great consequence, as shown by the full-lined ships in *fig.* 217.

But we want to move. B, has overlaid our south anchor, and,

Fig. 215.

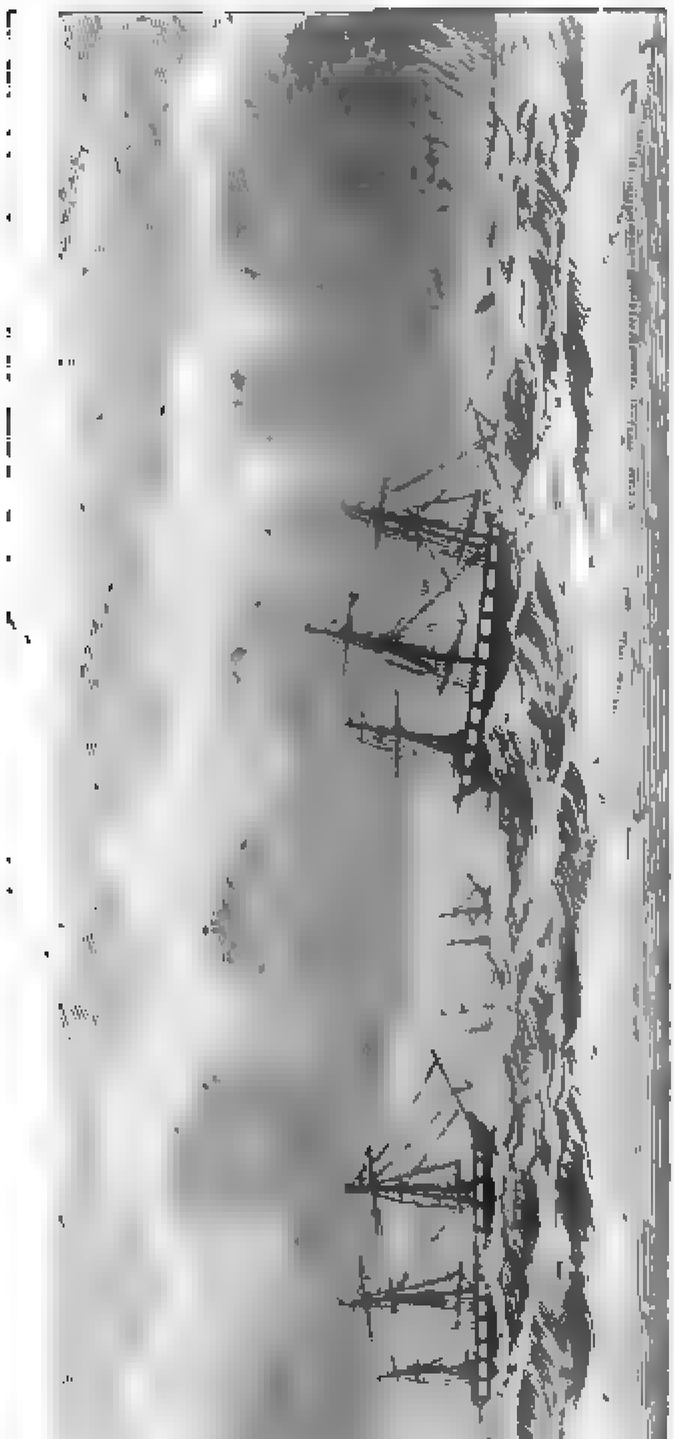


Fig. 217.

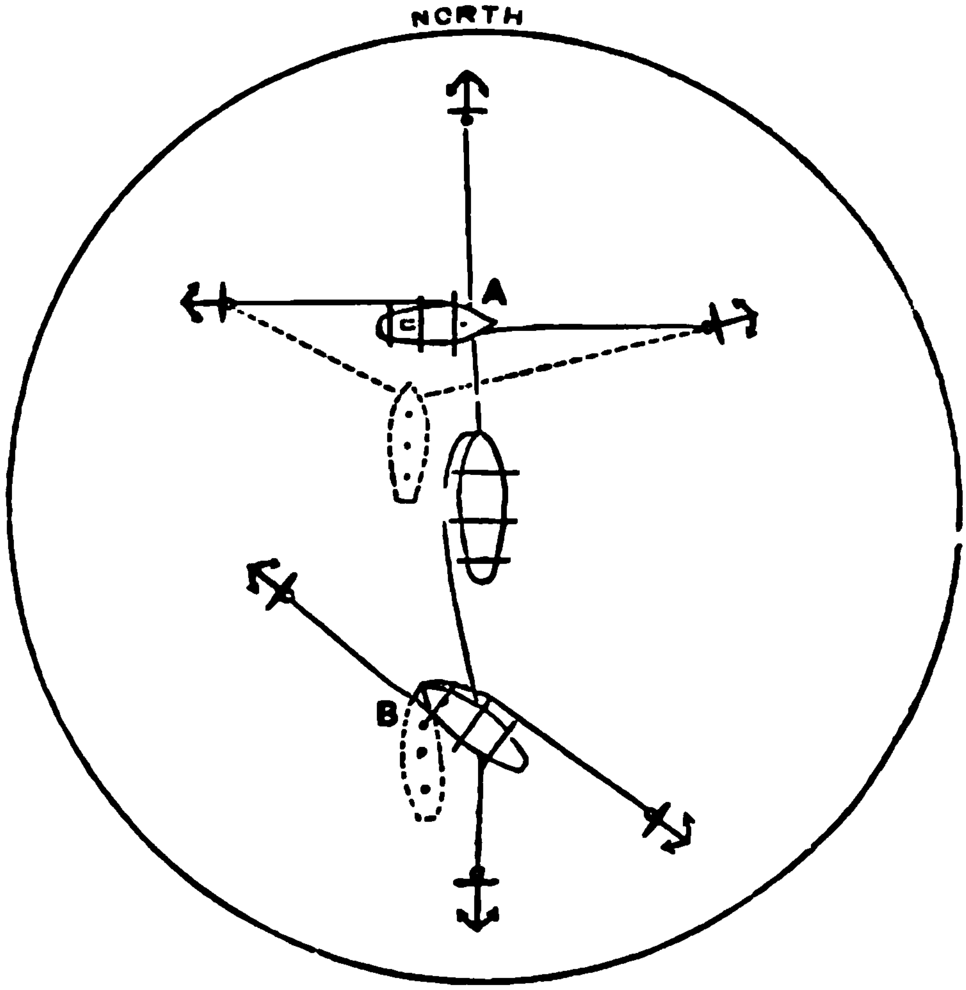
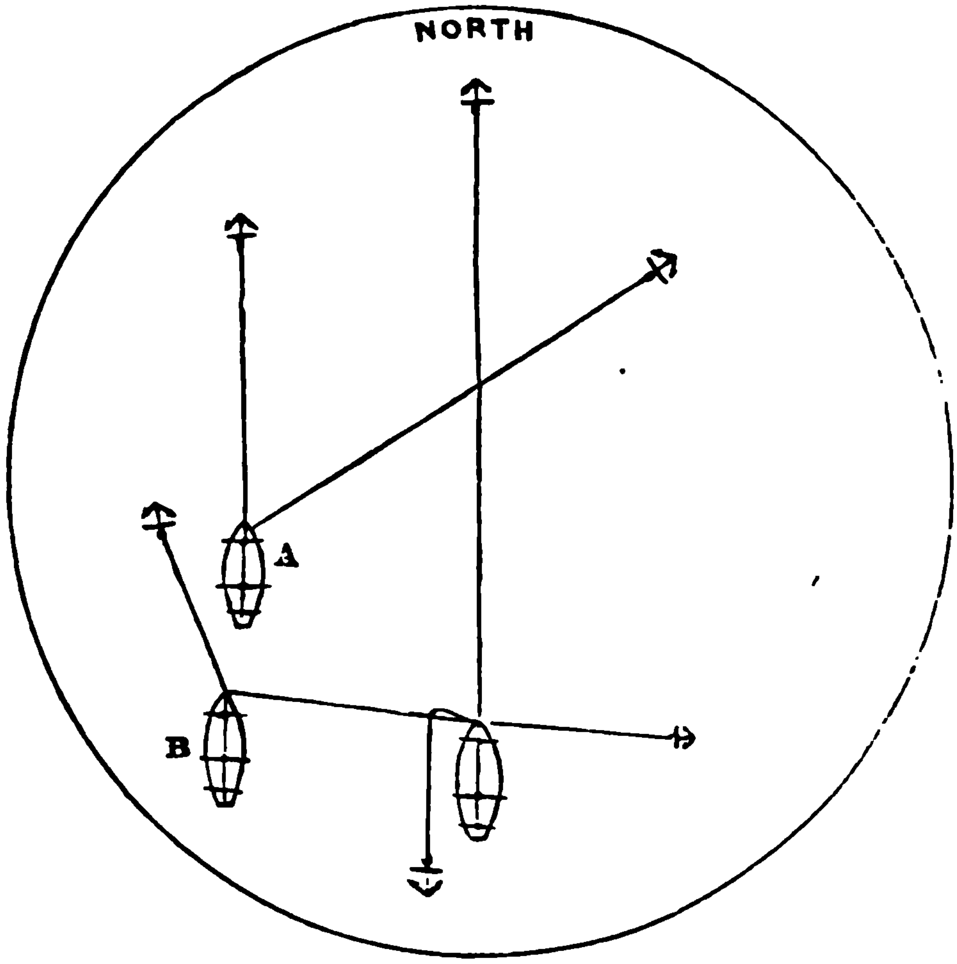


Fig. 218.



we cannot pick it up. A, has overlaid our north anchor, and we cannot pick it up.

Or it comes on to blow hard from the northward, and we want to veer ; but B is in our way, and we must hold on until it pleases him to veer, and he, either from neglect or ignorance in thus mooring his ship, sees no distress.

A has swung close to our port bow, as in the dotted line ship, *fig.* 217., his starboard cable is sawing at our weather one ; both A and B moreover, are riding on spans, and our ship and A see much distress.

At length we will suppose that B veers cable, and then that we and A veer cable ; our new positions would be as in *fig.* 218., and if a sudden lull or shift of wind occurred, the distress would be general. For we, as well as B, would have to wait for A, and B for us, before enough cable could be shortened in to keep the ships clear of each other.

Thus then it is that, when the admiral desires to have his ships as close together as possible, he orders them to moor ; and to prevent collisions whilst veering or picking up their anchors, he points out the direction of the anchors. To preserve likewise an imposing and well dressed line, he specifies the quantity of cable that is to be veered by each, and also enforces the use of buoys, that each ship may be enabled to ascertain the position of another's anchors.

These are some, but not all, of the reasons for mooring. For instance, in a river too narrow for a ship to swing in at single anchor without grounding, or too shoal to do so without striking on the upper pee of her anchor, and perhaps settling on it as the tide fell, it would be necessary to make her a fixture. But this also would require consideration. By laying the anchors out in a line with the stream, the anchors would be in the best position for holding in the event of freshes or gales coming on, in concert with the tide; but, excepting the small distance she could sheer by the action of the helm, her exposure to collision from an enemy's fire ships or rafts dropping down with the tide, or from vessels navigating the river, would be great; whereas, by having the anchors athwart the stream, either cable could be veered, and the ship quickly moved to one side or other. It is in such a case as the latter, that Porter's anchor is so useful; for, admitting of disconnection, it can be carried into shoaler water than the ship could reach, and greater scope of cable in consequence given.

Marking the buoys with colours peculiar to the ships to which they belong, is a means of removing much perplexity from the mind of a new comer, when looking for a berth on joining a squadron.

The state of the hawse may be known by fixing two pieces of silk thread to the compass card in the direction of the anchors, and fastening their ends to some place above it; for, for every turn in the cables there will be found a corresponding one in the threads.

FOUL HAWSE.

Knowing what open hawse is, let us see what foul hawse means.

The natural consequence of the ship pivoting is, that the cables become twisted together.

If she is "taut moored," these turns will occur close to the hawse holes, and the nip will be very severe, but being within reach they are readily cleared.

If she is "slack moored," they will occur under water, and are very troublesome, but not so injurious to the cable.

In either case the hawse is "foul," and until it be cleared you are in danger of parting, should it blow; moreover, you can neither shorten in cable nor veer.

As the question "How is the hawse?" is often put, we will endeavour to answer it.

Let us suppose a ship to have her small bower (the port one) out north, and her best bower (the starboard one) out south; her head north, and the hawse open. She swings to a breeze or current with her head to west; there will then be a "cross," small bower uppermost. (*Fig.* 219.)

Fig. 219.

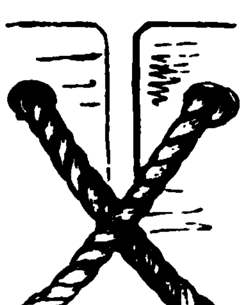


Fig. 220.

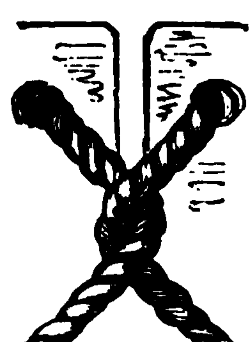


Fig. 221.

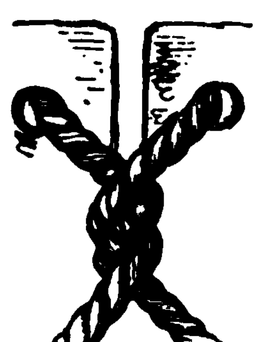
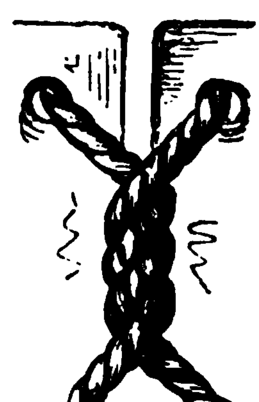


Fig. 222.



Follow her head on to south, there will be the same result.

Follow it to east, there will be an "elbow," small bower under, *Fig.* 220.

" north, the same.
" west, a "round turn," *Fig.* 221.
" south, the same.
" east, a "round turn and elbow," *Fig.* 222.
" north, the same.
" west, two round turns ; and so on.

Had the wind followed the ship regularly round, the consequences of foul hawse would have been inevitable ; but if the wind had been variable they might have been prevented. If for instance, when the head was west with a cross, the wind had come from east, and the spanker had been quickly hauled on to the boom on the port quarter, the stern would have been carried round by the southward to west and the cross taken out. On the other hand, if the ship had been left to chance, and her stern had been carried by north round to west, the cross would have become an elbow.

In a tide way with the first of the current coming up astern, a move of the rudder would carry the stern round in the required direction, provided there was no adverse wind.

An unexpected order to sail would find a foul hawse ship unprepared. The ready compliance of a clear hawse ship would bring her credit, and that might be due to the personal vigilance of the officer in charge of the deck at the time when the wind or tide changed; for without disturbing a single man from his meals or bed, the sentries and quarter-master could haul the sail out.

As to veering, as in *fig.* 215. The ship would sheer about more or less, as the wind struck either bow; therefore it would be necessary to heave in the slack of the lee cable to steady her. Moreover, were the slack chain not hove in, its bight would be dragged foul of the lee anchor.

CLEARING HAWSE.

How to clear hawse is the next question.

This may be done in calm weather, when there is no current, with the screw and steam. With the helm hard-a-starboard a few dashes at full speed will send the stern to starboard, and *vice versâ;* or it may be towed round by boats, or hauled round by hawsers.

The method generally adopted is the following:—If the turns are above water, put the clear hawse-shackle or the slip-stopper on the lee cable, below the turns; pass the end of a large hawser through the outer hawse hole on the lee cable side; reeve it through the roller part of the shackle or the shackle of the slip, then back through the same hawse hole and make it fast round the after bitts; clap the deck tackle on the other part; rowse it well taut, and make it fast also at the same place, or shackle the end of the stream chain to the slip. A wet hawser is thus avoided. Observe, we are going to speak only of the lee cable.

If there is a shackle in the cable before the fore bitts, you need not unbitt. Bend a hawser on to the cable a few links before the shackle, seizing its end well; keep it taut, "light to" the cable abaft the shackle, and unshackle; unreeve the hauling ends of the fore-bowlines from the bows, and pass them down before all to the cables; hand one of them in through the lee cable hawse hole, and bend it to the foremost end of the cable, putting stops on from the bend to the hawse hole, which are to be cut as the cable is thus carried steadily outboard: ease the hawser and haul the end out with the bowline. The object of the hawser is to preserve hold of the cable in case the clearing shackle should carry away.

With the bowlines and any other contrivance you like, the end of the lee cable is "dipt," and untwisted from the other, and then hauled back through its own hawse hole, and re-shackled: the deck tackle hauls it in taut; and when taut round the bitts, along the deck, through the cowl, stoppered, and the compressor tackle bowsed to, the slip is knocked off and the hawse is clear.

When the turns are low down, it will be necessary to heave in on the weather cable, and if the turns are too taut together to admit of the slip being put on, the cables are lashed together as low down as possible, and the same process of clearing carried out.

Another way is to put the mooring swivel on, and then to slew the turns out with levers and whips.

It must be observed, that as the ship is riding by the weather cable, it would be dangerous to unshackle it; and therefore the lee one is disconnected for the purpose of dipping the end.

MOORING SWIVEL.

It is to avoid this fouling of hawse that the mooring swivel is brought into use.

If it is intended to moor with the swivel, it is most convenient before coming to, to run up what will be the weather cable; putting the swivel in it (generally at the fifth shackle), and paying it down again.

When the cables are middled after mooring, let the swivel be above water, hang the lee cable with the slip as before, connect its outer end with the spare lower leg of the swivel, and its inboard end with the spare upper one, haul the lee cable taut and secure it, put some rounding on the cables to preserve the copper from the galvanic action, take the slip off and middle the cables, or bridles, as these parts are now called.

TO PUT THE SWIVEL ON AFTER MOORING.

This is usually done at slack water, which is in fact the best time for all cable operations, as there is then less strain and consequently less liability to break adrift.

Heave in the shackle of the cable by which the ship is most rode, sufficiently far to admit of the cable being well secured, whilst the swivel is being shackled abaft the securities. Then ease it out, and deal with it as before.

Some officers prefer bringing the outer end of the other cable into the riding cable hawse hole, and shackling it to the swivel whilst inboard. There is no great choice. The important thing to attend to is that the ends are secured.

The swivel should be put on with the cup upwards, as it may be more efficiently lubricated when in that position.

As there is an odd link on one side, and an even number on the other, it is well to make a rule of putting the odd one on the starboard chain. Without some such law, there will be frequent mistakes, and always difficulty in discerning the particular cable when all are hove in board to take the swivel off.

A taut moor is very trying to the swivel, and when it is used, there should be a liberal allowance of chain. The objection to a slack moor is that if turns are taken in the cables, they generally occur so low down as to be difficult to clear. If we purposed

mooring with the swivel with four shackles each way in ten fathoms water, and we veered seven on the first anchor let go, then by letting go the second anchor, and heaving in to the fourth, we should have a fair proportion.

Another way of putting the swivel on, is to put the chain slip on the lee cable, bring the end of the stream chain to it after passing it through the riding cable hawse hole, and then heave the bight of the lee cable inboard alongside the weather one. In such case, both bridles, as well as the legs are connected at once.

The decks are less encumbered, and the ship supposed to be equally safe, when one of the bridles is unshackled, and bent to the ganger of the sheet anchor in preference to having a third cable on deck. The stream chain in such case is usually bent as a bridle in lieu of the large bridle. The swivel is hove well out of the water, hanging mainly by the remaining large bridle. The advantage of this way is, that the stem is less injured, and turns cannot occur in the chains without being at once evident.

To moor in a tide way when the anchors are to be laid out in a line with the tide, and the wind is not too strong in an opposite direction to prevent the ship from dropping with the tide, it is usual to let go the first anchor, so that by veering, the ship may be carried with the tide to the proper place for letting go the second ; but where the anchors must be laid out aslant or athwart the tide, there is some difficulty involved, and considerable skill required. Under steam it is thought best to unbitt what will be the lee cable (calling that point to which the tide runs the lee), get the line of bearing on, let go the lee anchor, steer straight on (regulating the way so as to stop when there is cable enough run out), then to let go the weather one, and middle the cables. A Screw will not always take a ship straight astern.

Under sail, if the wind is nearly from the same quarter as the tide, get the line of bearing on whilst to windward, run down upon it (regulating sail to strength of wind and tide) ; let go the weather anchor, veering away roundly, steer straight on, and drop the second anchor where there is enough of the weather cable run out. This is what is called a running moor, and the objection to resorting to this expedient is the great strain which is necessarily brought on every article concerned in bringing the ship up.

SECURING CABLES.

Let us now examine the fastenings. The principal are the Bitting and Compressing. In addition to these are the Deck stoppers, and Ring stoppers, which are made fast to the large shoulder ring bolts in the decks. No severe strain should be brought on these bolts except in the direction to which the shoulder points.

Deck stoppers are shackled or hooked (according to fitment) to the ring bolts, the knot part hauled taut' forward, twisted round the cable, and lashed to it with its lanyard.

Ring stoppers are middled over the cable, and the ends, after being passed through the ring bolt, dogged forward along the cable. Thus, as the cable tautens, the nip of the bight is also tautened.

If it blow heavily, or is likely to do so, the cables are double bitted, *i. e.*, bitted to the aftermost of the foremost bitts in addition. In doing this, the cable is well lashed, and opportunity taken of a lull for slacking up abaft, whilst the bight of the chain is thrown over the second bitt head.

The Bitt Stopper is similar to the Ring Stopper. It is rove through a hole in the knee of the bitts, and is used chiefly for the hemp cable.

In Veering cable during bad weather, great care is taken, not only to do so during a lull, but also to slacken and tauten all the fastenings at the same time.

Cable is veered not only on account of the long scope we have spoken of, but also to "freshen the nips;" and in doing so, it is well to keep the shackles and swivels free of bitts and hawse holes.

UNMOORING.

In unmooring, the lee anchor is picked up first, because whilst heaving in on the weather-cable, the ship's movements can be controlled by the helm; whereas were the weather one picked up first, the ship would drift down unmanageably towards the lee one at the risk of fouling that anchor, and injuring other ships, besides probably getting too near a lee shore. When the

tide is very strong in the opposite direction to the wind, the ship will sometimes be tide rode, and lie with her broadside to the wind. So many circumstances require consideration in this case, that we shall leave it for personal observation to find out which would be the proper anchor to begin with. One restriction would be a cross, and this would probably involve the lower cable first; for were the upper one worked, not only would the cables grind, but the anchor on breaking ground would foul the lower cable.

Fore-top men always work before the bitts.

Main-top men abaft the bitts.

If the hook ropes are led round the rollers, and the people properly stationed, the messenger is run up into its place without a check.

Place the links of the messenger on the sprocket of the capstan, see the turns taken out of the chain, and splice the ends, heaving it taut with the rollers that are in the manger if necessary.

Let us suppose the best bower (or starboard anchor) first. Pass plenty of nippers before the bitts round the starboard cable and messengers; reeve a hook rope through the bitt block, which is fast to the beam just over the bitt head; hook on to the bight of the chain that is round the bitts, and pass the end round the messenger abaft the bitts; cast all the fastenings off the best bower cable; light it to and heave in on the small bower, and the hook rope will unbitt it, if it is fast to the proper link. When the swivel is at the bitts, put the slip on the best bower chain and hang the best bower bridle; (both of these are now in board on the port side;) walk back the capstan until the shackles of these two parts of chain are slack enough; paul the capstan whilst the men are working among these bights of chain; disconnect the best bower from the mooring swivel; connect its ends; haul taut the starboard compressor, and slip best bower, stopper small bower before all, and bitt it *; now bring to best bower as we did small bower; unbitt it, and heave in, veering away so roundly on small bower, that it shall hang up and down clear of

* In ships having a great space before the bitts, it would not be necessary to unbitt small bower. Whether the swivel be taken off small bower now, or when it is hove in again on shortening in that cable, would be a matter of choice. All things considered, time would be gained by deferring this duty.

the copper; take the nippers off when abreast the second bitts; hold on small bower when nearly over best bower (this will be known by the cable marks). Let the nippers go further aft; bowse to the starboard compressor, and keep enough best bower chain on deck for catting and bitting; and the best bower buoy may be got hold of now. If it be a heavy heave, put the long tackle on the cable, or run the end of a hawser thrice round the fore capstan, and hitch it round the cable and messenger close to the hawse hole; man it with the spare cable hands (all except the nipper men are standing idle), and heave both capstans. If still heavy, clap a lashing block on the cable, reeve the hawser through, and make its end fast to the bitts; take racking turns with dry nippers (if the cable is greasy, throw sand on it). The moment the anchor starts, off with the purchase, and the after capstan will do the rest.

When the anchor is at the hawse hole, warn the men to stand to their bars, for they are apt to stand easy after a heavy heave. Put the slip on the cable before the bitts, and walk back the capstan, bringing the weight of the anchor gradually on the slip; then paul the capstan (because, should the slip carry away whilst the nippers are on, the messenger would drag the capstan round before the men were clear of the bars *); then off nippers.

FOUL ANCHOR.

Now were the question put on a passing day, "What is to be done under the above circumstances?" probably the answer given would be an account of how to clear the anchor. But there is a whole cable out, the ship is veering about, and it is necessary that the small bower should be hove in immediately; and as that is done in just the same manner as the other, we shall proceed to clear the starboard anchor while the port cable is being hove in.

If the cable is foul of the stock, hook on the cat to the ring. The cat-back is managed by the cat-back rope.

Cat and fish falls are apt to ride, therefore see that they are scored before hauling taut.

* This is by no means improbable, especially if the cat has been smartly hooked and well hauled on by numbers of spare hands on the upper deck.

When the cat is taut in all its parts, stand clear the cable and knock the slip off; when there is cable enough stuck out, stopper and bitt it.

Marking the anchor part of the cable for catting dispenses with much noise and delay.

A few turns of the chain may be taken out by slewing the anchor round with ropes to the stock. If not, hang the cable near the shackle to the cat-head, ease the anchor far enough down to slacken it, and then unshackle it, take the turns off the stock, shackle the cable, and hoist the anchor up again, pass the cat-stopper and unhook the cat.

Cat-blocks when close up would, from their great breadth, be split, if kept hooked whilst fishing the anchor.

Hook the fish on the inner arm from forward aft, put a tackle on the after end of the stock abaft the cat-head, haul the fish and stock tackle, and, as the fluke rises with the fish, the lower end of the stock will be thrown clear of the bows by the tackle, otherwise it would foul the chain and bind. In all chain cable operations, the invaluable pellet of lead must be used with every pin.

When the fish is up, either slack the martingale and pull up, or, if no martingale, pull up the topping lift, and when the fluke is on the bill board, pass the shank painter under and over, and unhook the fish; take the tackle off and haul the chain taut in.

Should the cable have so fouled the anchor as to bring it up crown upwards, hook the cat to a good strop on the crown; haul the cat, and veer cable until the anchor plombs the cat-head with the crown awash; then hook the fish to another strop on the crown, and to relieve the fish, hang the cable with a rope from the cat-head to the hawse hole; hoist the crown up with the fish, hook the cat to the ring, and hoist it up, pass the stoppers, unshackle, and clear the chain.

If the davit gear is much worn, cat the crown in the first place, hang it with the cat-stopper, then hook the cat to the ring before all, and the fish to the arm; ease down the cat-stopper, hauling on the cat and fish at the same time.

We seldom get over a foul-anchor, without having a man overboard. Sailors will not be slung in a bow line knot, unless forced; and even when so slung cannot work efficiently. "Clear hawse breeches" are inexpressibly useful. Make them of painted canvass, roomy and wooden soled at the feet, well roped

and fitted with two spans long enough to clear a man's head when bent to a rope. In these a man can work dry, effectively, and safely.

ANCHORING.

When it is optional, moor in northern latitudes with reference to the chances being strongly in favour of gales beginning at south-west, and ending at north-west.

For the same reason, in northern latitudes, lie at single anchor with the small bower (the port anchor) and if you have to let go a second, you will have open hawse.

Shortening "all sail" together in coming to an anchor, however well done aloft, cannot but crowd the decks at a time when you want silence and the power of carrying out a sudden alteration in your plans. Except when you want to "charge" into a station with great way, or catch breezes over the land with your lofty canvass, the seamanlike way to come to is under topsails, after the coursers and upper sails have been "whipt in," and the upper yards well squared by the boatswain's mates from the tops. You can then feel your way with the topsails, deaden it with a check of the braces, freshen it with a small addition of canvass, or stop it by throwing aback.

When about to shorten sail, get the marks of the lee lower lifts down; clue up; man all the braces and trusses, and lower and square all together.

In coming in, whilst blowing hard, get as much sail reefed and furled as you can spare with prudence, the top-gallant masts on deck, top tackle gear rove, studding sails out of the rigging, and the cables double bitted. If running, round to before letting go.

Letting go and stowing the sheet is capital practice for the youngsters; therefore, when it blows strong, never hesitate or "wait till she drags." Either down with the second or third anchor, or veer more than one cable on end.

Make it a law to bend sheet cable whenever (if not sooner) you let go your second anchor. In other words, always have another anchor ready for letting go.

The order generally is "put the lead over the side;" put the deep sea lead over also, but put it over the bows. If you cast it clear of the cables, it will be a more certain indicator of the ship dragging her anchor.

If you break adrift from one anchor, it is best to let go two at the same time.

If you have not double bitted before coming to, do so without delay. You not only relieve the wood work, but can veer with less jerking.

Always double bitt before anchoring in deep water.

If you are likely to use the sheet, get the lower boom out of the way, and hang the cable taut from the fore end of the chains; for if you let it hang in a long bight from the anchor to the hawse hole, its weight will drag the anchor forward the instant you let go, and the inner bill will (in many ships) catch the after dead eye and hang the anchor.

If you ease off well and hang the cable, you may throw the anchor off the tumbler, clear of everything.

Should you use a buoy, do not part with it until veering obliges you. A sheet buoy is very apt to foul the bower cables. When there is much sea on, the rudder chocks save the braces, pintles, tiller, and wheel ropes from severe strain.

If you want to back your anchor with another one, on account of dragging, or the danger of doing so, put an anchor shackle on the riding cable; shackle the end of the backing anchor cable (taken outside all) to this; look out for, or give the ship a sheer, and let go.

The rolling motion may be checked, when at anchor, provided there be not too much wind, by making sail and bracing by. This is no unimportant object, especially in handling boats.

No one that could help it would moor in a roadstead. At single anchor a ship is ready for sea, and her remaining anchors are disposable for a gale from any quarter.

SINGLE ANCHOR.

In coming to an anchor, it is desirable to run the cable out straight, clear of the anchor, after letting go. To do this we must either wait for sternway before letting go, or else let go whilst there is headway on, and pay out roundly.

For the former there must be wind enough (if there is no tide) to force the ship astern. In the latter there is the chance of damaging the copper and snapping the chain, and thus of running on board of a vessel which we had reckoned on clearing.

It is evidently an unnecessary risk in strong breezes, and therefore only adopted in light, when the risk is small.

The object in thus laying out the cable is, that not only will the anchor be clear, but that (excepting in strong breezes or tides), the ship will ride far from her anchor by the mere weight of the chain, where it rises from the bottom. As long as this is the case, the anchor will be clear; but when she comes to be carried near her anchor (which is known by the buoy), it will be necessary to take measures to prevent this; and it may be done by an early attention to the state of the wind or tide.

If, for example, the ship was riding to a moderate north wind and a strong tide set in from south, she would naturally be carried over her anchor, and the chain would foul it; but if the jibs had been set, she would have sailed in a semicircle round her anchor, and swung to the tide to the northward of it.

The short of what is called "trending," is keeping the ship away from the buoy; and when it comes rapping on the copper at night, it is a sign, in most cases, that there is no one "at home" on deck.

The inconveniences of boating experienced in an outsider are trifles compared to the dangers that are inseparably connected with an inshore anchorage. A close lee shore in a gale, with one ship drifting in the hawse, and another too close astern to admit of veering, are the prices which must be paid for having what is sometimes called "a snug berth." A real good berth is to be well to windward, at single anchor, and (on making up for the night) to have the boats in and up, topsails treble reefed, a reef in the mainsail, stay sails bent, top-gallant mast on deck, yards pointed to the wind, cable ready for slipping, driver double reefed, guns secured, rain awning sloped. Being thus ready for the worst, the ship may be called "snug."

When becalmed at night in a tideway or current, in the neighbourhood of foul ground or land, ease an anchor down to the hawse hole with a slip rope hawser, and then lower it by the cable a few fathoms below the ship's draught. The chances will be in favour of its bringing the ship up before, perhaps, striking the ground.

Ships draw less water at a great inclination, than when upright; therefore, when heaving or backing off from the ground let the people "sally," by the toll of the bell, from side to side—

one bell to starboard, two bells to port — striking nearly at the last of each roll. If on sand, she will displace it on each side. A fresh pull on the purchase will be required after every rolling.

CREEPING FOR ANCHORS.

Ships are sometimes unable to weigh their anchors from stress of weather or haste, in which case the chain, having a buoy rope and buoy fast to it, is "slipt." Again, when the cable has parted, the only trace of the anchor is the buoy. But buoys frequently are washed away, and as the whereabouts of the anchor is known, it is "crept for" in the direction of the compass bearings.* Boats having a rope with weights on the bight, which keep it at the bottom, row on parallel lines at some distance apart. When the rope comes in contact with the flukes of the anchor the boats cross each other's path; a hawser is hauled round the fluke by bending its end to an end of the creeping rope; an anchor shackle is put on both parts of the hawser, which running down to the anchor jams them together, so that they do not slip off whilst weighing the anchor. Of course the best way to sweep will be to row in a line with the shank, and nothing is so efficient to sweep with as a piece of small chain. If there be a tide running, it will save boats' crews much toil to lay two small kedges out before commencing to sweep, by which the boats can be warped to and fro. In creeping for a cable, two fish-hooks joined at the eyes, and kept apart with their hooks in the same direction by a few small battens lashed across their backs, form an excellent creeper. It is dragged by the eyes, and kept hooks downward by a small back rope. Boat's anchors also form creepers; but, as the back rope is the only means of disengaging the creeper from anything it may become entangled with at the bottom, it must never be omitted.

CARRYING AN ANCHOR OUT BY BOAT.

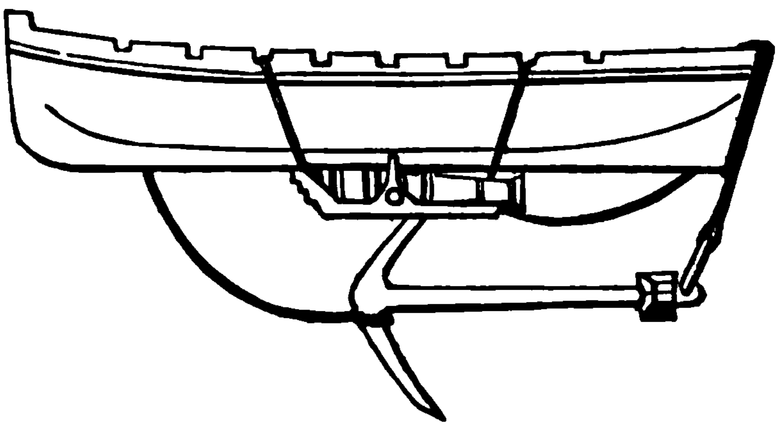
With boats having tubes fitted to their bottoms, the anchor is lowered down, and the flukes are hove up to the boat's bottom by

* Light loses about half its intensity every fifteen feet under water; but it is said that a convex lens burns at twenty-five feet under the surface of the sea, in a diving bell. Substances which reflect strongly may be seen with the water telescope at the depth of twelve fathoms. Cables are sometimes rubbed bright on the bottom, and might therefore be spied with the glass. It might be worth while to paint anchor stocks white on this account.

two parts of a stout rope, the bight of which is round an arm of the anchor; the ends are led up through the pipes and brought to the windlass. (*Fig.* 221.)

The stock is hung horizontally from the stern.

Fig. 221.



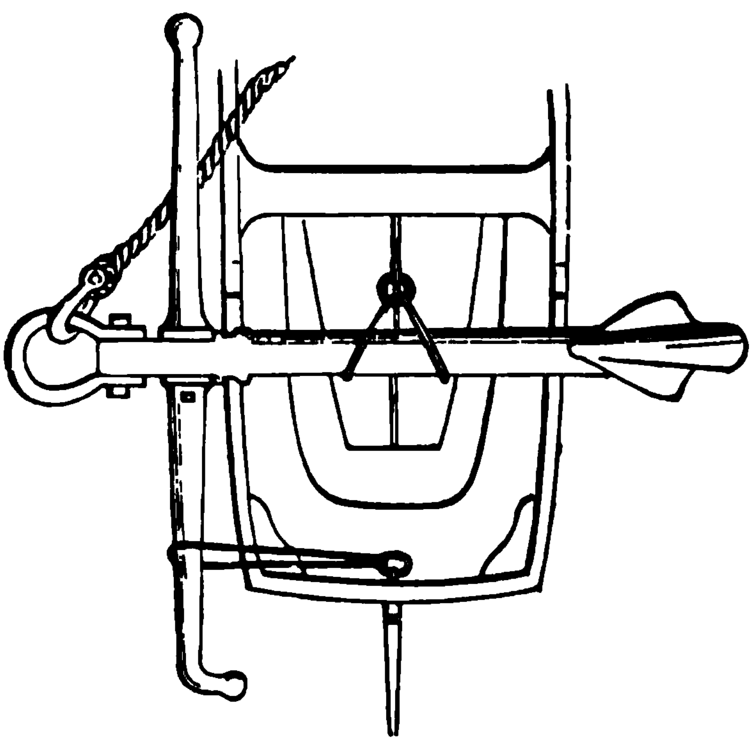
Heavy guns are carried in much the same way.

STREAM ANCHOR.

In carrying the stream anchor out, receive it athwart the after part of the boat.

Hoist it out by the ring; when the crown is below the gun-

Fig. 222.



wale, hang it with a rope from the bottom bolt round the arms, and as it is lowered, bear the stock over the opposite gunwale, and bend the cable on under the stock after you have rolled the anchor aft. In this way you can steer, which you cannot when you place the flukes over the stern, with the stock resting athwart the boat on two fore and aft spars (*fig.* 222.).

Moreover you can pull the after oars.

Of course with a short anchor you have no alternative. Place the midship thwart across the stern, lay two capstan bars fore and aft, and land the anchor on this platform fore and aft, with the flukes over the stern.

It is well to fit the Stream with slings, in which case it can be landed in its place across the boat without a moment's delay.

When likely to weigh a stream or other heavy anchor by boat, put a block on the crown and reeve a double buoy rope through it before letting go.

CARRYING ANCHOR BY BOAT WHEN THE SHIP IS ASHORE.

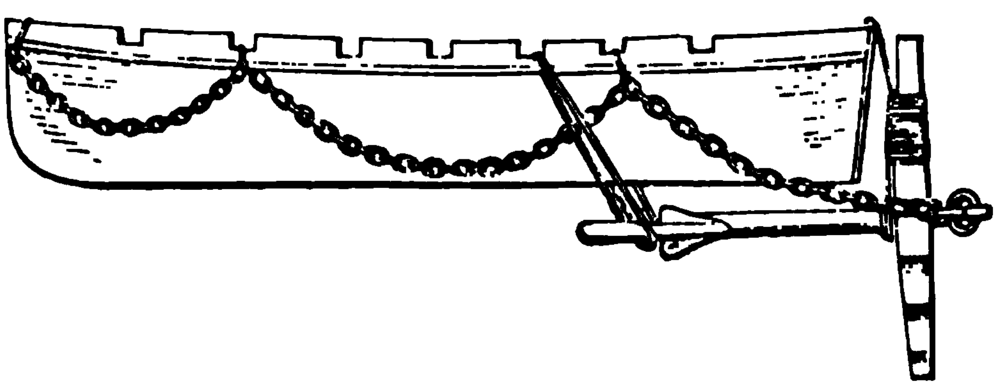
The quick way to lay a bower out when it is too dark and too urgent to be bungling with bottom tubes and spar lashings over two boats is, "out boats, rig fish davit."

If it be breezy, you will want to haul out with a small anchor, so put the kedge and hawser at once in a pinnace. An officer with the cutters will meanwhile have sounded and decided on the direction for the bower, and shown his position by the flash pans or light. The barge will help the pinnace to tow. Send the end of the deep sea lead-line with them, and when they have run out a hundred fathom of it in the right direction, let go the kedge, and bring the end of the hawser to the ship's bow.

While the davit is being rigged, two large thimbles are seized into two strops, which are clapt round the outer arms of the anchor, and the end of a short buoy rope rove through them, which is stopt to the shank to keep it middled. A long pair of slings are put round the shank before the stock, and lashed to its upper end to keep the stock perpendicular. Round the shank also, and with its ends stopt up and down the upper end of the stock, is passed the bitt stopper, or some such piece of rope; hook the fish to the inner arm from aft forward; hook the cat to the stock slings, and ease the anchor down, keeping the

shank horizontal and the stock perpendicular until it is about four feet under water; bring the launch's stern against the stock; haul her side in close to the fish; secure the stock end of the anchor to the stern by the ring-stopper, passing the turns through all the stern ringbolts; bring the ends of the buoy rope in taut on each side through the rowlocks, and secure their bights through the foremost ringbolts; ease up and unhook cat and fish; stop a length of chain round the boat outside, and then range as much more chain in the bottom as is intended to be carried out, stopping it in several places, and making the end well fast that it may not fetch way in veering.

Fig. 223.



When about to let go the anchor, make sure by a cast of the lead that you have cable enough outside the boat to reach the bottom, and hang it well to the stern that no more may run out. If there be a greater quantity of chain in the boat than can be ranged in one layer, there will be damage done unless you disconnect at the first shackle and bring it to the last one, which will be the upper one of the range paid down. Let go the anchor with the boat's bow *from* the ship, either cutting or slipping all its fastenings together. Lash a capstan bar athwart the stern; lay the cable over it and veer away cautiously fathom by fathom. If the end of another cable is brought to you, join it; hang the joining shackle outside your boat, and throw the bight out, letting both parts hang from the stern *over* the bar—that is to say, have no cable now remaining in the boat, and when all is clear, slip the bight.

This proceeding will suggest the necessity of always taking punches, pellets, and hammers in a boat, when setting out on an anchor expedition.

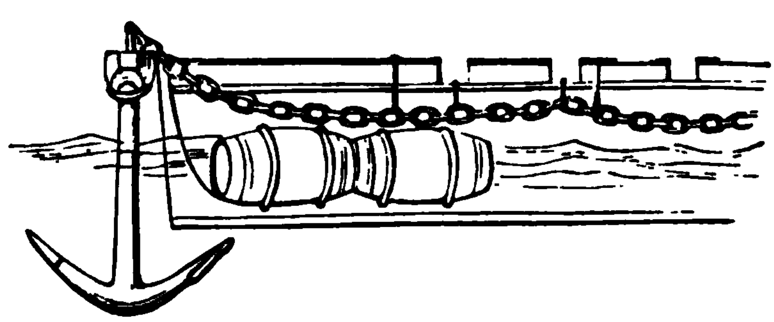
HEAVING OFF.

Ships sometimes get hard and fast after grounding, from neglecting to lay anchors out before lightening. In some cases, the water close under the stern is too deep for anchoring. It is reported that the bower anchors of an English man-of-war, that had grounded in the St. Lawrence, were transported over the decks; and, being let go from the quarters with a purchase on each, which was carried to the bows, the ship was hove off.

CARRYING ANCHORS WITH BOATS.

When the boat is unequal to the weight, sling four empty butts in pairs, marrying their slings, and "snaking" them, so as to prevent them from being shaken off. Bung the casks well, weigh the stern of the boat, and bear the butts underneath. This will increase the buoyant power of the boat about two tons. With a large launch prepared in this manner, the anchor may be lowered, and hung with its stock horizontally across the upper part of the stern as in *fig.* 224., and a whole cable carried out. Of all methods this is certainly the quickest, and moreover the boat will tow more easily than with the anchor entirely under her bottom.

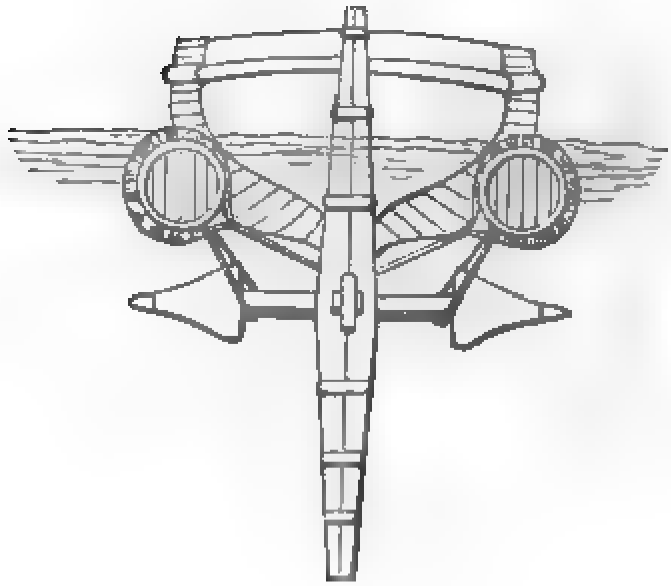
Fig. 224.



If the anchor were too heavy to admit of its being carried in this manner, its flukes must be hove up under the bottom, and the stock secured in the perpendicular, as in *fig.* 225.

In lowering the waist anchor by the tackles *into* a boat, hook the main tackle on the inner arm, and the fore tackle inside on the lower stock, so as lay it with the stock athwart ships.

Fig. 225.



RE-STOWING WAIST ANCHORS.

It is common to use the same arrangement of tackles for re-stowing waist anchors, as is made in hoisting the launch in. Suppose the starboard anchor: The main yard is braced forward, and the fore yard aft on the starboard side, and both secured in that position. Put a strong preventer brace on the starboard fore yard from the bowsprit cap, and a burton on its quarter for the cable. Cat the anchor on the right slue, with the upper stock aft; hook the main runner and main tackle to a strop on the crown, and mowse their hooks; hook the fore-runner to the ring, and the fore-tackle to a strop made fast to the ring, and lashed half-way up the upper stock; pass a hawser over the cat-head stopper-cleat, through the anchor ring, and make its end fast round the cat-head. Hook the yard burton under the cat-head inside the hawser to the cable, about three fathoms from the ring; ease the anchor down by the hawser; let it hang with the ring awash and unhook the cat. (The use of the hawser is to avoid the difficulty there would be in overhauling the cat aft.) Haul taut all the gear, easing away the hawser, and paying out cable, bearing in mind that the more the anchor is slacked away under the yards, the more equally will the runners operate. Keep the bight of the chain up with the

burton, and the upper stock with the fore-tackle. If the drift is long, put another tackle from the cat-head on the cable, so as to relieve the burton, and let the anchor go aft freely; when up, the main tackle — and if not, the fore-stay — will bring the fluke in on the bill board.

In very long ships, the yards must necessarily be braced very much in, and, consequently, the pee of the anchor will bind very much against the side in going aft, bringing severe strain on the yards; and when it is remembered that their principal duty is to carry sail, and that injury may be done them whilst lifting weights, without their exhibiting any present symptoms of distress, it seems unwise to employ them for purposes which can be better effected with other means. At all events, when lower yards are struck, there is no alternative, and the davit, as already described, is brought into operation.

TO STOW THE WAIST ANCHOR WITH THE DAVITS.

Rig both davits, one a little before the place where the stock stows, and the other at where the fluke stows. Use the cat-fall and cat-block (taken from the opposite side) for the foremost one, and the usual fish gear for the after one. When the anchor is up to the hawse hole, hook, haul taut and belay the cat-head cat and stick out cable; hook the after cat to the anchor ring, and the fore yard burton to the cable as before; pay out chain; lower the anchor well down, so as to overhaul plenty of cat, and then hoist the anchor right up to the foremost davit, and fish it with the other one. This is only one more davit to rig than usual, and can be done whilst shortening in cable. In fact, the only difference of time between stowing a bower and waist anchor in this way is that which elapses whilst hooking the second cat; for, although the length of haul on the after cat is greater than that on the main one, we lose none in handling the stock tackle. Five minutes' difference would be a liberal allowance, and yet how often is the sheet anchor grudged from the imaginary difficulty about stowing it!

STRIKING LOWER YARDS AND TOP MASTS.

The old custom whilst riding out a gale, was to strike top-masts, keeping the lower yards up, seeing that not only do the

yards hold less wind when pointed aloft than when square below, but that in the event of parting, sail might be made. And one ship did succeed in getting off a lee shore under these very circumstances. The heels of the topmasts were hung by hawsers in addition to the top tackles, and the topsails were set close reefed over reefed courses.

In lifting to take the fids out, topmen will not start the rigging lanyards if they can avoid it, because in sending masts and yards up afterwards, they like to find the rigging all ready taut for them to run the moment the fid is in. The rigging is generally much shrunk from wet whilst the mast is struck ; and unless the lanyards are actually overhauled, the strain on top blocks and cap bolts is excessive, and accidents are frequent in consequence. Topsail lifts, buntlines, and reef tackles must also be lighted up; and before lowering the masts, the backstays and halyards must be hung taut from the top. Indeed, to make a good run with the masts in going up, all this gear should be hauled up above their usual nips and stopt. Of course, when striking, if rolling heavily, the rigging must be very carefully eased ; the lower yard should either be braced up or lowered out of the way, and sail tackle put on the mast head, or the buntlines racked to haul down with, so as to take advantage of a lull for unfidding and lowering rapidly.

If the yards are to be struck whilst rolling, cross the yard tackles to opposite sides of the deck, and check the after main braces whilst lifting the slip out. When the masts and yards are down, haul the stays taut with jiggers, and pull them up through their nips and hang them there. Rack the clue garnets under the yards.

When the lower or flying jib booms are left out after striking lower yards and topmasts, or pointing yards to the wind, it looks more like negligence than design.

In sending up lower yards and topmasts, have jiggers on stays and backstays ready for setting up. If there is a fight for an inch for fidding, either something is fast, or there are not hands enough on the dumb sheave tackle, or the heel is wooded in being pulled aslant by the live one ; therefore, divide the men at once, slack the live tackle a little, and then one long pull together will toss the mast up. Top sail lifts are generally the cause of a heavy pull. The nip is short in the sister-block, and unless the lift be hauled

through and hung outside the block, it will give trouble. It is the same with top-gallant rigging; haul it up a few inches through the nips, hang it there, stop it taut into the topmast rigging from the cross tree, and then stop the bights taut up and down the topmast rigging; thus the rigging will not only be well overhauled, but the unsightliness of loose gear at the mast head will be avoided. In sending top-gallant masts up, the men must be warned to cut the stops on the bights only, as they go aloft.

Tricing the after main braces up, overhauling the sheets of courses, and letting the bunt of courses fall (of course refurling) before sending the lower yards up, lighten work. The bunt of a large main sail will, after heavy rain, contain more than half a ton of water.

See that the heels of the booms are fast, for if not, and the yards tilt, they will slip overboard and wring the irons.

CHAP. XXIV.

HANDLING THE SHIP.

In the government of the peopled deck there is scope for administrative talent of the highest order. To be prompt with the right command, judicious in the selection of sufficient means (and no more), in the control of reserves, in the anticipation of the next move and contrivance that the present command have some reference to the future, in the adaptation of resources to various circumstances,—all this cannot be learned in any other school than one "under canvass," or by any other pupil than a cordial lover of his profession.

The military art may, in a great measure, be reduced to rules. It is almost a certainty that an order will produce certain results. The commander moves his pieces with nearly the precision of a chess-player. He literally can say to a man "Do this, and he doeth it." At the note of a bugle, columns form line, consolidate

in masses, or deploy into fractions; a battle is declined, or an inevitable disaster is converted by successful generalship into an honourable retreat.

But the seaman is dependent on two uncompromising agents; and however, he may accommodate his circumstances to their movements, over them he has no positive control. Britannia may rule the waves in song, but, as the sea-sick dominie observed, "She cannot rule them straight."

Tides, seas, and winds will rise and fall, and wait for no man. The seaman must take them as they come, and be ready with his resources; and even after his best exertions, his gain or loss is in their power. A shift of wind threw three of thirteen ships out of the brunt of the battle of the Nile. The "Culloden," commanded by an officer whom Nelson had named "the Non-pareil," grounded on a sunken rock. Fogs and calms obscured the signals and retarded the movements of Howe. A gale scattered the hard won trophies of Trafalgar, and prevented the entire destruction of the enemy; and it was in the full conviction of the impossibility of adhering rigidly to fixed rules, that the genius of Nelson threw himself so trustfully on the bravery of his men and the undirected ability of his captains.

These observations are not made with the intention of drawing an invidious comparison, but to magnify our own profession in the estimation of young sea officers; so that they may take a large estimate of the qualifications for command. If the wooden walls be made up of "Hearts of Oak," the "thin Red line" is composed of materials as precious; and soldiers and sailors can entertain no rivalry that is not of a friendly and honourable character.

It is true that steam may place his forces more at the disposal of the naval Commander-in-Chief than formerly, but bearings may get hot, shells may drop into the best masked engine room, and machinery of the most perfect description may fail at the hour of need; and without meaning to maintain the infallibility of sailoring, it is not very certain that coal whips will altogether outlive tacks and sheets.

It has been observed by an officer, whose high scientific attainments place him beyond the suspicion of disparaging theoretic knowledge, that however informed, taught, and improved by book learning naval officers may be, they are aware that sea-

manship is the most essential part of their education; that it can only be learnt afloat and by practice; that it needs certain qualities of head, eye, character, and constitution, *not easily or quickly acquired;* but therefore proportionately valuable. Neither the differential calculus nor dynamical study will enable an officer to manage his ship in a gale of wind, or an action. He must neither overlook nor undervalue plain duties, while studying mathematics and philosophy.

CASTING.

When there is plenty of sea room, and the wind is fair, it is best to cast under the head sails: and to make sail when before the wind.

In casting with the square sails set, ships invariably gather sternway the moment that the anchor breaks ground. On this account, and under these circumstances, it is considered a good general rule (in the case of a foul wind), to cast with the head towards the nearest of neighbouring dangers to make a stern board while the anchor is being catted, then to fill and make sail enough to insure going about in stays when requisite.

When there is not room enough to admit of going much astern, set the main sail before starting the anchor, and have a purchase all ready to clap on the cable the moment that the anchor promises to give a heavy heave; otherwise the ship may go tripping it astern into shoaler water, and certainly will be unmanageable until it is at the bows.

When close to a lee shore with too much wind or sea to get the anchor easily, or when you cannot afford to go astern, the ship must be cast with a spring, and the anchor abandoned. Thus, supposing that the ship is riding at the starboard anchor and that it is determined to cast to port, brace the yards up on the starboard tack, have the sails ready for setting, with the number of reefs in that may be necessary; hoist the top-sail yards up sufficiently high for setting the topsails, and cast as many gaskets off as can be spared. Pass one end of a buoy rope in through the riding cable hawse hole, and make it fast to that cable close before the bitts, put a buoy on the outer end, and hang it outside all to the bumpkin. If riding with nearly a whole cable out, prepare to disconnect its end from the slip in the locker, drive the pellets out and see the cable clear

for running. If riding with only part of a cable out, you may be able to disconnect further up, and thereby save so much chain; but it would not be prudent to unshackle until the ship is sure of going the right way, for a flaw of wind might bring her to, after having gone off to port a certain number of points, and it would then be necessary to hold on for another trial. In such case unusual strain would be brought on the cable fastenings, and if they carried away or rendered and the cable were unshackled, you would be adrift; but were it still connected, the clench would bring you up.

Pass the end of a hawser from the starboard quarter outside all, and make it fast for a spring to the riding cable at the hawse hole; haul it taut, make it fast, and have an axe ready for cutting it. Haul the head sheets aft on the starboard side. Be all ready to loose and make sail and veer cable. Put the helm a-starboard, and when the ship's head is sheering to port, hoist the head sails, veer away cable, and put the helm amidships; when the head sails have taken well, and the ship is evidently swinging from her quarter by the spring, disconnect the cable, warning the people to stand clear of the end, and let go the buoy. Set the courses, and then the topsails, if not able to set all at once; and when the wind is well on the starboard beam (and not sooner, otherwise the ship will fly into the wind before she has steerage way enough to keep her out of it), cut the spring, trim the head sails, and when you have good way on, bring her gradually to the wind.

When you have room, and are pitching, it will be best to get the anchor up before making sail. By so doing you will ease the chain, nippers, capstan, messenger, &c. &c.

When about to get under weigh (the ship being tide rode, and the wind aft), the comparative strength of wind and tide must be well considered before coming to the decision to make sail and weigh, or to weigh first and make sail afterwards. For it looks ill to see a ship under canvass forging ahead over her anchor, tearing the copper off her bottom, breaking the nippers, and sheering unmanageably about before breaking ground; and it is equally bad management when the anchor is hove up, and the ship is drifted by the tide without steerage way.

If the wind were light, it might be necessary to make nearly all sail before breaking ground; or if moderate, merely to loose

them. If it were blowing strong, the ship might stem the tide without any sail; but in this latter case, it would be well to have a head sail set, so as to prevent the possibility of breaking the Sheer whilst stowing the anchor.

TACKING.

In turning to windward, if the ship be in trim, her weights well disposed, her sails not only well set but judiciously balanced, there will be a lively strain on the weather wheel ropes, yielding to the influence of a single spoke: but challenging again, the ship will not "bore," or pitch, or flam as if about to beat her head to pieces, or bury her bows in a head sea. Her head will rise and fall in easy graceful undulations; there will be a tremulous motion in the tiller, a sensible pulsation which is said to be an infallible sign of good trim, denoting the amount of life and energy in the whole thing. Like a well mouthed pulling horse, if the wheel be let go at the moment when the pull is strongest, she will dart ardently into the wind, and go round of her own accord.

Let us take her then at one of these moments. Haul the spanker boom over, ease off the head sheets, and steer her round.

When the sails "touch," run the main tack up as far as the bowline will permit, else the blocks will get inside the main rigging on hauling the after yards. Shorten in the lee main tack until the leech is taut nearly in a line from the yard arm to the chestree; pull up the lee boom topping lift, and overhaul the weather one; gather the weather main sheet through, and see that it is clear outside.

The first run with the main sheet and preventer main brac requires great activity, but not much strength. These rope have many fathoms of slack to be run through before the heav pull comes. So have your men stationed in gangs; one to ru or rather rush away, and the others to strike in. It is from in attention to this arrangement that we see jibs make an awkwar "halt" in the middle of the stay when being set, and the mai yard fly back square after having been "up."

The Main Braces will of course be worked forward on bot parts. If we have several pieces of bunting let into the belayin

part, there will be no delay in making it fast when the yard is round, and then hauling on the other; have the weather preventer main brace and main top bowline hauled quite through the sheaves, and hung by a stopper; a kink during the swing of the yard would spring it.

After the main top-sail "lifts," it will gradually become aback from the middle outwards. When the weather outer cloths have taken aback, the ship's motion will then throw the sail alternately forward and aft; take it as it bellies aft, and having your men awake at the bowlines and braces, "main sail haul." The wind will then have been about two or more points on the bow, and will chase that side of the topsail aft, carrying the main yard up in one swing on the other tack, where it will remain if the brace has been smartly worked.

The forecastle men always want to get their share of the work done, and, unless prevented, will begin shifting the head sheets over as soon as they have done another piece of mischief in letting go, and raising the fore sheet at the word "helms a lee."

When head to wind, shift over head sheets.

Now is the time for a pull on stays and halyards, upper sheets, &c. *

Man head braces, fore tack, and sheet.

If she is flying off fast, you may haul the head yards a little before the main topsail is full; if not, it is better to make sure of the head yards being quite full on being hauled. Whether it be from great lateral pressure of the water before gathering good way, or the bulk of the people being before the centre, ships are apt to come to, after an early haul of the head yards, and hang in the wind; perhaps involving "boxing off," at all events causing more loss, than if you had made a late haul with them.

As for the helm, if touched at all, the ship should be steered round, and righted when the wind is on the other bow.

The "touchiness" of a ship's trim is nearly incredible, and often unaccountable; one will be carrying a press of sail all day to keep station, and at night be stirring her leader up under half the same quantity of canvass; one day we hear that a notorious

* New gear is always giving out. If topsail yards have much drift between the hanging blocks, it is best to take a pull on the lee halyards before going about.

clipper "won't sail a bit," and the "dummies" cutting all the work out to windward. During one commission a ship is fast or slow, the next quite the contrary.

All this but goes to prove that generally there is sailing in a ship, and that if she cannot be a flyer she need not be a slug.

So trim, trim, trim; a "pocket" jigger and half a dozen hands may do it all. It does not follow that, with a slack weather helm, a pull on the driver sheet is the remedy; perhaps an inch of the jib sheet or fore brace would have been better. Nor, until you study the case and try, can you decide whether a check of the boom sheet, or a reef in the driver, or a pull on the lee head braces or jib sheet is the best cure for a taut one. When you think of these things, remember in your boat how you can correct weather helm, without reducing after sail, by a pull on the jib outhaul or sheet, and *vice versâ*; and also what a change can be made by shifting a sitter his own breadth.

Keep the lee after main brace triced up clear of the davits, and have a hand by the tricing line when going about. Some few seamen prefer having the brace always kept taut, but often forget to let it go when getting a pull on the main tack.

When there is much sea on the bow, or when there is a swell with little wind, the ship will require coaxing. Take opportunities when she is inclining to come to, to haul the head sails down; ease the helm down, haul over the boom, and check the head bowlines and lee head braces. Look out for stern way, and if the sails have taken aback, and it is not intended to use the rudder for steering purposes, put it amid ships and pass the twiddling lines.

When performing any evolution in the Line, if sail will ensure it, do not hesitate to make a sufficiency, even if it should be taken in immediately afterwards. Missing stays, or taking up much time and space in wearing, throws other ships into danger and disorder.

You may have been carrying enough sail to keep your station but it does not follow that you have enough to carry you round when the signal for an evolution is made. If your leader is dull but doing his best and in his station, of course you must not encroach on him; but you must be handy with your canvass, and sharp in freshening your way with it, just before your own turn comes to go about.

In every evolution "in succession," the eye of the chief is on each performer as he goes round, and when after a bad one he asks for the name of the officer of the watch, the query is generally followed by an invitation to the flag-ship, not to dinner.

When about to leave the main yard square in stays, make a late haul, else the brace will go.

The rule for going about in succession in close order in the line is, to put the helm down when your next ahead is four points on the weather bow; in open order, five points.

In wearing, begin when he is on your lee bow.

WEARING.

In tacking with a strong breeze, there is danger to the masts from the pressure of the sails when aback, as they are then supported only by the stays. This is sometimes so imminent, that when the sails begin to shake and are no longer useful in carrying way, the topsails are lowered, and only hoisted again when the ship is round on the other tack.

There is also danger of the ship missing stays from the pressure of water in a sea way on the weather bow, in which case the stern way is so great as to risk the rudder fastenings and stern fitments.

Again, when it is blowing strong, it is not possible to set enough sail to carry the ship round.

In these, or other cases, when there is enough of sea room, the ship's head is got round on the other tack by "wearing."

If they have been in use, put preventer braces on the lee side before going round; brail up the driver; let go the after bow lines; ease off the main tack and sheet; put the helm up and spill the after yards, taking down the slack of the lifts and trusses. When the wind is on the quarter, brace in the head yards, and square the after ones; when the wind is aft, shift over the head sheets, and (if working with the watch) run the head yards right up on the new tack, for if smart, you will get the foresail well set in good time whilst it is becalmed. Ease the after yards forward as the wind is drawn on the quarter; gathering aft the main sheet, and hauling down the tack. Set the driver, ease the helm, and put it a-weather as she comes to, else the ship will fly up in the wind.

When working with the watch, it is best to haul the main sail up before wearing; and if you want to wear short, you must not brace the head yard up until you have nearly got the wind a-beam on the other tack.

When blowing so hard as to be under stay sails, and perhaps close-reefed main topsail, wearing requires great care, as to the very time when to bring the wind and sea a-beam on either tack. Unless you prefer running the risk of having a sea come on board, ports stove in, boats washed away and tiller snapped, you will put the ship off and bring her to the wind during one of those temporary smooths which occur in the heaviest seas. The more way you have on, the more powerfully will the rudder act; so by all means set the foresail, hauling it up when before the wind. The trusses must be attended during the evolution, and rolling tackles and preventer braces put on before it is commenced. The mizen and main trysail will of course be down, but if you put luffs on for sheets from the opposite side, and steady them whilst going round, it is much better not to haul the stay sails down. Unship the galley funnel if it be in the way, but if you attempt to carry the main stay sail sheet round before it after hauling down, you will be a long while without sail enough over the body of the ship, and will very probably take a sea in.

The relieving tackles must be attended. As there will now be much working of gear aloft, the yards should be kept off the lee rigging and stays, and bunts of courses clear of lower stays.

By getting the people aft, the ship's head will go off more readily.

In all cases, wearing strains gear less than tacking.

CRACKING ON.

"Cracking on" perpetually through everything, conveys the idea of "making a capital passage." Certainly good runs have been occasionally made under a constant press of sail with continuous breezes, but then experience proves their rarity.

How often, after straining every spar, rope, and sail, wetting and rewetting before the men's clothes have had time to dry, do ships wait for days in stark calms for winds.

It is well to reflect on the risk to the ship, and exposure of the

crew, caused by a wanton desire to hold on to the last, and drag through a squall when the case is not urgent. If you are reckless enough to carry on without any precaution in threatening weather, or unfeeling enough to do so with your men "standing by," whilst you in an armour of waterproof defy the weather, the chances are always in favour of an ugly cloud bringing you wind enough to oblige you to shorten sail. Rain is the general accompaniment; and as the men cannot work in tarpaulins, they are drenched during the operation, and remain so whilst damages are being repaired which a little common sense might have avoided.

TAKEN ABACK.

"Taken aback" is scarcely an admissible term. Sudden shifts of wind are not very frequent, for generally a lull or calm intervenes, or the wind shifts gradually round. In either case there is time to get the main sail and driver in, steer the ship's head off, or brace the after yards round to meet the new comer.

As it is impossible to do anything until these two sails are disposed of, there can scarcely be an excuse for finding them set whilst there is a prospect of a serious change of wind or weather.

When appearances are very threatening, and it is difficult to say from which quarter the storm will break, the wise course to pursue is to clue everything up (if not furl), keeping a fore stay sail set. And the officer of the watch must not always take it for granted that *somebody* is looking after scuttles and lower deck ports.

Hauling courses up in a calm or when aback cuts up the ratlines very much. These sails will be raised more properly by using the bunt lines and leech lines only at the first. If the wind is light, haul the lee clue forward with the tack, and then haul up.

MAN OVERBOARD.

Every ship has a particular station bill for this occurrence, but as it happens under so many different circumstances, it is impossible to prescribe. The best preconcerted arrangements are often inapplicable, and success depends mainly on the presence of mind of the officer of the watch and the man at the life buoy.

A cool hand will drop the life buoy sometimes within reach of a man; a "bothered" one will either not let go at all, or do so before the man has got near the stern.

If on a wind, there can be no question about "going about;" leaving the main yard square on the other tack, and lowering the boats when ready.

If sailing off the wind, every thing light must be let fly, and the ship rounded to. *

A hand with his wits about him must endeavour from aloft to keep the man in sight.

The boat's pendants and the "pull to port," "pull to starboard," and "you go well" signals must be bent on instantly, so as to be ready to hoist and correct each other.

If at night, have blue lights and rockets ready for showing the ship's position to the boat.

If on the fleet, the ship's position lights should be shown as quickly as possible.

As the boats are supposed always to have the means of flashing or firing, you will know their whereabouts.

Netfulls of cork shaving or old corks kept at different parts of the upper deck, are most useful whilst bathing; the men are encouraged to "take the water," knowing that one of these will be pitched right into his hands when he is fatigued; and in the case of a man overboard it will most probably be in the power of the person who gives the alarm thus to afford immediate relief.

They can also be sent in boats when you must risk a capsise.

TAKING A SHIP IN TOW UNDER SAIL.

Both ships must steer in line ahead on a preconcerted compass course, sufficiently off the wind to ensure steady steerage, and under easy sail. When the sternmost ship is close to her leader, her way can be deadened by touching the sails with the braces; and if the leader has thrown a buoy overboard with a light line fast to it, it can be picked up from the dolphin striker of the other ship, and a hawser hauled in. If the attempt is made on a wind, the buoy will generally be carried past the weather bow

* In all cases of letting fly gear suddenly, never forget to warn the look-out men who are on the yards

of the ship astern. We should always pass to windward of the ship that we mean to tow.

WARPING.

The resistance offered by the Log-ship when it is towed with the pin fast, will give an idea of what may be done with some boards, towards warping a ship in a calm. Lash two mess tables athwart two gratings; span each grating from its four corners, and seize an eye in middle of their bights. Tow this out by a boat in which a warp is carried; pay and go. When far enough, sling as many shot to one side of the float as will cause it to be quite immersed edgeways, making lines fast to the shot slings that they may be raised when requisite for the purpose of laying the float out again.

SHAKING OUT REEFS.

In shaking reefs out, becketed sails do not require to be braced in; but all square sails are much better set by checking lee braces and letting the yards hang naturally whilst hoisting.

In shaking reefs out, throw the points asunder; ease the reef tackles down as the reefs are cleared; and do not wait until the sail is hoisted to get a pull on the sheet. When a point is found jambed on hoisting, either settle the halyards at once or girt the sail well up with the buntlines.

Checking the halyards grudgingly, only delays the duty: settle them roundly at once, so that when the men get on the yard, there will be no risk from jerking and lowering with a half turn. The halyards will be fast, the reef tackles and buntlines well taut, and a slack leech presents an easy earing. Lowering with men on the yard is most unseamanlike and dangerous.

FORE AND AFT SAILS.

The sheets of fore and aft sails should be steadied aft before hoisting, and eased carefully as they are hoisted.

UPPER SAILS.

In setting upper sails in fine weather, let the Loosers (after casting off the outer gaskets) stand on the mast heads, "let fall,

sheet home, and hoist" at once. In breezy weather make them come down before hoisting, and when taking these sails in, do so *before* the furlers reach the mast head; for their additional weight there with the sail set may carry the already complaining mast over the side.

Many a top-gallant purchase carries away because the foot rope has got under the cap

TAUT GEAR.

In all transitions from dry warm weather to cold or wet, the gear "takes up" surprisingly. Halyards, sheets, &c., should be slacked in due time, especially at night.

DEADENING WAY.

Backing the mizen topsail is considered very objectionable, and in the line is expressly forbidden.

To square the main yard on a wind, it is only necessary to let go the braces, bowlines, and main sheet; and all this can be done by the lee wheel and look-out men. If it be a fresh breeze, ease the preventer brace, remembering the strain on stays.

COLLISION.

On a collision in steaming, upright the screw. In that case gear dragging overboard will not foul it, otherwise it will.

On a collision taking place when in soundings, it is generally best for the weathermost ship to anchor.

When two ships are becalmed near each other, either send the boats of both to tow the lightest, or of the one that lies in the most favourable position, (with reference to swell) for being moved; or else, run warps out from the quarter of one to the bow of the other, and *vice versâ*, and both may thus be sprung ahead and steered clear of each other.

In passing dangerously close by another ship or other obstacle, remember that when the helm is put over to prevent collision, it is the stern that moves, and that while the bow may be thus saved from touching, the stern may be fouled; but that if the helm be quickly shifted when the bow is *just* clear, the stern will be thrown out. Many a "*touch-and-go shave*" has been thus effected by judgment and nerve.

SETTING STUDDING SAILS.

In setting studding sails, after the lifts and burtons are up, and the leeches of top-sails and top-gallant sails are steadied by the bowlines, trice the top-mast and top-gallant stud-sails up high enough to lie over the brace blocks, and rig all the booms out at the same time ; then man all the halyards and tacks, cut and slip the stops, and hoist away all together.

In setting stud-sails in a strong breeze, if you can keep the ship away until they are becalmed, you will get them up and well set when the gear would not stand otherwise.

You will carry the top-mast stud-sail as long as it will do good by using the lower halyards as a martingale ; making a knot on the bight in the top, and then rowsing the bending end down taut in the fore chains.

Remember that with top-mast and top-gallant stud-sails, the yards not only bear the weight of the sails, but also the downward drag which increases as the wind does, forcing the belly of the sails forwards, and acting like a span : therefore have the lifts and burtons well up before hoisting.

In bracing forward, studding sail tacks, boom braces, and topping lifts require careful attention.

In bracing in, unless the boom brace be manned, the chances will be in favour of the boom going anywhere but in a line with the yard.

In dipping the main top-mast stud-sail before the sail, the wind will be just enough on the opposite quarter to glance off the top-sail and blow the inner leech aft. If the course can be altered, the sail may readily be handled, otherwise the short way is to haul down, stop the bowline in on the main yard, and set the stud-sail before all.

It is no manner of use to dip a lee fore top-mast studding sail.

TAKING IN STUDDING SAILS.

In taking top-mast stud-sails in, it is well to start the tacks a little, so as to settle the tack blocks to their work before hauling down. In hauling down, ease away the tack before the outer arm of the yard touches the boom end ; and if the tack jambs,

which is not unfrequent, rig the boom in at once. The leverage is great, and boom irons are frequently broken in this way. With lower stud-sails which have been carried with the yards much forward, get a good pull of the tack and after guy before starting anything, else the lower boom will fly forward when the tack is let go.

Should the boom get under the bows, and the top-mast stud boom be in, put the lower halyards with a bowline knot round the lower boom, and haul them out with the lower tack; then, with these and the topping lift from the fore yard, it may be got up. If not, secure the heel, disconnect the gooseneck, and whip the spar up heel foremost.

Of course, if the ship can be kept away, and the foreyard braced in, all will be easier.

TAKING IN SAIL.

In taking top-gallant sails in on a wind, keep the weather sheet fast until the yard is down, which will be done all the sooner by hauling in the weather brace at the same time; then get the lee clue line and buntline up. Lay the yard, and keep it lifting, and rather aback with the helm until the gaskets are passed.

If before the wind, keep both sheets fast until the yard is down ; then clue up and brace by. The same practice applies to royals.

The Parrels of these yards are generally slack, and the yards should be bound when possible against the rigging by bracing in.

A royal carried too long before, and a top-gallant stud-sail carried too long near the wind, are the most difficult jobs that fall to a topman's lot to handle. Beyond a certain pace, these sails set as above cannot do the least good. If the "trimmer" is consulted whilst carrying a press of lofty sail before the wind, the ship will be found to be excessively out of trim by the head. Near the wind, the top-gallant stud-sail is fore and aft, bellying to leeward, and taking the wind out of the powerful forward pressing top-gallant sail.

Before the wind, stud-sails may be becalmed by a spoke of the helm, but the royal has no buntline ; every bound of the

sail shakes the top-gallant mast like a whip stick, and the men cannot "handle" it. There is no proper alternative but to let fly the clue lines, and let the sail blow to pieces. If the men have been allowed to go aloft to try and remedy the mischief, they won't come down, and cannot be made to hear until they have had a try. It becomes a point of honour with them not to give it up; and at last some bold fellow goes down the lift, and if not jerked off, passes the gasket from the yard-arm in.

Then as to the stud-sail. — It is easy for the officer to say, "In royals; haul down"—and to walk the deck as if he had done his share of the work; but ask the men, or take your place on the flying boom when the spar is pointing in the direction of the lee cat-head, and the sheets are banging like a volley of flails against it, as if the clerk of the weather was dying to lasso the poor furlers with their bights; or get up on the top-sail yard, when the stud-sail tack or halyards are let go (and you must let go one or other), and the sail flies away to leeward before the top-gallant sail, blowing out like a mandarin's streamer, doing all it can to walk off with the top-gallant mast, and bid you good bye. Then the lee top-gallant sheet cannot stand it any longer, and cracks, and the top-gallant yard goes fore and aft, and the weather top-gallant lift has a jigger on it, and will not yield. So away goes the whole of it, and it is "nobody's" fault, because "the right order" was given.

Or else the weather top-gallant brace goes, and we have the same consequences. Or, all the gear holds on, and the sail, after an effort, wisps itself up round the top-mast stay, from whence it is finally cut adrift; and the only consolation in the matter is the self-satisfied way with which the epitaph "Lost overboard by accident" is written in the log, and the yards of "number seven," which the topmen contrive to save for other than public purposes.*

It would be easy to ascertain the rate of sailing in different ships beyond which small sails are unavailing, and thus to establish some general regulations about them.

* "The difference I observe in the expense of sailing the ships is incredible. Some men who have the foresight to discern what our first difficulty will be, support and provide their ships by enchantment, one scarce knows how; while others, less provident, would exhaust a dock yard and still be in want."—*Collingwood's Letters.*

It would be easy to confine the carrying of the lower studding sail to a certain force and direction of wind, ensuring the benefits of a full fore sail, and avoiding the trouble that occurs when the lower boom and sail go under the bows; for instance, when the jib is drawing, the lower studding sail cannot be doing any good service.

We must again call attention to the use that may be made of the helm. When the men perceive that you understand how to throw a sail into their hands, with a turn of the wheel — either becalming it by bearing up, or spilling it by a careful luff — they will work with confidence and good will.

REEFING TOPSAILS.

If sailing with the squadron in moderate breezes run the yards in nearly square, else the men will lose time in getting on the weather yard arm.

It is considered neat to hand upper sails whilst reefing, letting fall as the topsails are hoisted; at least, the top-gallant sheets should be hauled taut after lowering their halyards to correspond with the reef. When double or treble reefing on a wind with courses set, on account of weather, bear in mind that the outer arms of the topsail yards are unsupported, and are unequal to the strain that may injudiciously be brought to bear on them, by over manning the reef tackle on deck. When the yard is laid, the duty of the reef tackle is to give the earing men plenty of slack leech between itself and the yard; and if it cannot effect this without much straining, (and this can easily be judged of by observing the tautness of the leeches *below* the reef tackles on each side,) raise the clues at once with the clue lines sufficiently for the purpose.

Pull the buntlines well up so as to girt the sail in for the bunt points.

Nothing is gained by permitting men to get out on the yard for reefing in a strong breeze until the yard is laid and the sail ready for them. Yard arms have been wrung off in the endeavour to make the reef tackle do all the duty of other gear, and the earing men's lives saved only by a seeming chance.

In reefing with the watch keep all the people on the deck until the yards are quite ready, and use the double halyards in hoisting.

The men employed at the yard arms in reefing will work all the better by having the foot ropes carried out to the boom iron, instead of being spliced round the yard arm, or else having the Flemish horse brought into the quarter of the yard.

In reefing at night in the line, observe if your second ahead and astern have more or less sail than top-sails. If you have been sparing them courses, you will be run into; and if they have been sparing them to you, you will run into your leader, unless you are alert.

After every evolution, (especially at night), make the petty officers report their ropes, and also immediately after relieving the watch. A few fathoms of the main brace checked by one hand will often just regulate the pace and keep the ship in station ; and, if let go at the instant, arrest danger.

Make grating platforms to coil working ropes on. The hour and half spent in darkness and helplessness whilst stoning decks in the morning watch, with ropes coiled up, is the principal reason for ships getting out of station about that time ; and for being found scattered at daylight after keeping together all night.

When all reefs are out, it will often be necessary in bracing sharp up to check the weather topsail halyards ; and the lower yards will pivot all the livelier, the closer the quarter blocks and leads of topsail sheets are to the bunt.

SETTING COURSES.

In trimming forward, get the tacks down before the lee braces are near their marks.

In setting courses on a wind, before hauling on board check lee braces ; for the bunt of the sails may be nipt, and at all events the tacks will come better down.

BOXING OFF.

From neglect at the helm, ships are brought "up in the wind" or caught in that position, by the wind shifting a few points forward. If there is good way on, the helm, if put quickly up, will "pay her off."

If she does not answer it at once, she will come round, for the jibs are shaking, and the weather halves of the square sails

forward are aback and "levering" the head round against the helm. But if you instantly brace the head yards quite round the other way, the "leverage," is all in your favour, and you will keep the ship on the same tack by this process, called "boxing off."

But whilst you are doing this, you will be going astern, therefore remember the rudder, and also, if in the line, what is close astern.

In squadron sailing, keep an eye on the wheel, *especially at the times of a fresh relief.*

TAKING IN THE DRIVER.

To take in a driver, much trouble and time will always be saved by bracing the cross jack yard in well, before starting the sheet. Man the lee brails best. When wearing in the line, or obliged to bear up suddenly, the after leech of the driver over the lee cross jack yard arm nearly neutralises the helm. When thus situated, let fly the mizen topsail sheets and throat halyards. When wearing in the line in succession, never reset the driver until well on the lee quarter of the sternmost ship.

In taking the first reef in a driver or boom main sail, it is not necessary to start the peek halyards. Lower the throat well; get the boom amidships, and lee topping left well taut, so that the men may get at the foot of the sail on the lee quarter. Belay the reef tackle to the boom. If it is taken to the bitts, and the reef cringle is close down, something will carry away when the boom is eased over after reefing at the first plunge of the ship. Double reefed drivers in a heavy breeze require preventer peek halyards and boom sheets. A mizen burton is the best for the former, a luff for the latter. If worked by brails, the outhaul should be shifted to the inner cheeks on the boom; for the foot of the sail is not calculated to bear such a strain as would be brought on it by hauling out to the boom end. Moreover, the sail would be distorted. In reefing, the canvass is to be tied (not rolled up), and the points should be knotted on their bights. If it is reefed with a pendant, the tack tricing line becomes a working rope of much consequence. It will relieve the ship when necessary from the effects of weather helm; and if triced up in doubtful weather, will drag the jaws of the gaff down the moment the throat halyards are let go.

In reefing, the pendant of the last reef is stoppered to the boom, whilst the reef tackle is shifted to the next.

In furling, crutch the boom and belay both sheets.

The peck downhauls are not strong enough for peek guys whilst the men are leaning on the gaff; therefore, pass the ends of the boom sheets over the gaff ends as well, and from each side. The utility of boom jackstays will now be experienced.

TAKING THE JIB IN.

If the men are ready at the cap to lay out, the ship need not be five minutes off her course, if kept away for the purpose of becalming it. None but the very best seamen can master a jib that has been carried into a strong breeze, and unless assisted by the helm they are in great peril. There is an art in slacking the jib sheet at the right time when hauling down.

If the downhaul carries away, the top-gallant bowlines have the same lead; and bowline knotted at the masthead round the jib-stay will bring the sail down.

The jib-stay should be slacked in rough weather whenever the sail is taken in; there is always time enough to pull it up whilst the sail is being loosed.

SENDING TOP-GALLANT MASTS AND YARDS DOWN.

Always stop the yard ropes out to leeward. Tell your men off before sending them up; so many to "off purchase," "to light up," to stop out, to unbend sheets and clue lines. Put a tripping-line on the weather yard-arm, and send the yard (if at sea) down through lubbers' hole.

The top men will not let go the Jacob's ladder lanyards, be they ever so taut, unless you *make* them. They like keeping them thus, so as to be ready to "shin up" and rig the royal yard the instant (if not before) the fid is in—a most dangerous practice. Pull up; if rolling, attend the rigging falls and back-stays, but keep a fair strain on stays, take the main fid out, then the preventer; put a heel rope on; lower to the rigging mark; if the mast hangs, a pull on the yard rope will start it; clap two half hitches on the lizard (you may have a little trouble to get it through lubbers' hole, bracing forward, &c., but it is worth it).

Lay the mast fore and aft the deck, and parcel the mast rope fo chafes in the wake of the top rim.

You will now have a good opportunity of overhauling mas ropes and masthead sheaves.

Misunderstanding often occurs from the vagueness of pipe about top-gallant masts; therefore, make a law, that "down top gallant masts" means on deck; "strike top-gallant masts," tha yard ropes are not unrove and masts only lowered to th hounds; "howse top-gallant masts," that heels are nearly o the topsail yards, top-gallant yard ropes of course unrove.

When upper yards are sent down at sea, ship on a wind. I should be remembered, if she goes on the other tack, how th yard ropes lead, and how the yard-arms lie, in case they migh be suddenly wanted.

If the yards are likely to be long down, it will be worth whil to lessen the bunts by opening the clues out along the yard they will thus stow much more snugly.

In sending top-gallant masts down at sea or shifting them, th question of before or abaft the topsail yards must depend o circumstances. If on a wind, the heel of the mast can generall be cleared abaft the yard by lowering the yard half way down but if the parrel be taut, and the mast hole not rounded awa previously in the fore part, there will be difficulty. On th other hand, if the weather side of the topsail be clued up, th buntlines hauled up and yard squared, it must be thrown quit aback, else the sail will belly forward and foul the heel of th mast. This might be inadmissible in racing or squadro sailing; and yet in an average number of cases, perhaps, i is the quickest way.

WEATHER BRACE CARRIED AWAY.

When a weather brace carries away; the yard immediatel becomes a lever; the stay, or parrel, or truss, being the Fu crum; the lee rigging, the Weight; and the wind, the Power.

The remedy will depend on the amount of Power. If be small, a new brace is rove, or the old one is repaired with long splice.

In substituting new running rigging for old, when the run c the lead is not lost, the ends are spliced, or stopt together; and

as one is run off, the other enters its place; otherwise, men must be sent aloft to reeve the gears.

When the Power is great, the yard or parrel will be the next thing to go; for the yard flies fore and aft, and even the mast is jeoparded. In this case, it is dangerous to send men on the yard, or delay until the brace is repaired; and, therefore, the sail must be taken in immediately.

If it be a topsail or top-gallant brace, clue the sail up; and if the clue lines or downhauls do not start the yard, the lee bowline will drag it clear of its nip.

If it be a lower brace, lower the topsail, letting fly the lee sheet, and hauling in the weather brace if needful. Ease off the sheet of the course (short of splitting the sail), and let go the tack, for the first important duty is to save the yard. One scend might break the brace, the next would break the yard; but there would just be time enough between the scends for a quick ready officer to start all the principal gear that would relieve the spar.

If this accident occurs forward, the Weather helm must be attended to. A quarter-master who knew his duty would drop the peck, or let fly the mizen topsail sheets without waiting for orders, while the officer was occupied in saving the yard.

TOPSAIL BRACE AND PARREL CARRIED AWAY.

This rarely happens where the security of the parrels, tacks, and sheet fastenings, and all that gear which is likely to be handled whilst exercising, are made matters of special report.

In a strong breeze on a wind, when the yard is nipt so hard by the lee rigging and stay that it cannot be got down by the clue lines or downhaul, after clueing the sail up, send the end of a hawser up abaft the top to the topmast head; pass it round both ties, and make it fast to the after cap bolt. Haul down on the hawser, easing away the halyards until the yard is on the cap; clap on the new parrel; lash the yard by the quarters to the topmast rigging, and then repair the braces.

If the wind is aft, clue up, and hoist the yard close up to the hanging blocks. This will keep it steady until the hawser is passed round the ties.

TOP-GALLANT BRACE AND PARREL CARRIED AWAY.

In this case, where sending men to the mast head is out of the question, and clue lines have failed, there is every chance of losing the mast if you hold on, and of the clues getting round the stay if you let go the sheets. The lower and topsail yard must be braced by, and the ship, if necessary, sufficiently touched with the helm, to throw the top-gallant sail slightly aback.

PREVENTER BRACES, LIFTS, AND CLUB LINES.

Preventer brace pendants, made long enough to reach from the yard arm to the top, are not only quickly attached to the whips, but the risk sometimes incurred in sending men on the yards greatly diminished. Preventer topsail braces have more drift and a more downward pull than the standing ones ; and, therefore, should never be so taut, or be hauled upon, until the lifts are well up.

In carrying a press of sail, Burtons on the topsail yards give great support, especially if they have been pulled up in concert with the standing lift when the sail was being hoisted, or during a good "lift."

The general rule for topsail lift jiggers, is to put them on when the second reefs are taken in. And it is good to make a habit of putting the spare parrels and preventer braces on when the third are taken in.

When top-gallant yards are sent down on account of weather throw the top-gallant sheets out of the snatches ; reeve them through the bow line bridle of the topsails up before all, and hitch them to the lugs of the tie blocks. They will be found to act even better than leech lines of courses when taking in topsails.

From their greater length, the sail tackles are generally used for preventer lower ; and the topmast studding sail halyards for the Preventer topsail braces.

REEFING TOPSAILS AND COURSES.

Haul up the courses, lower the topsails, and round all the weather braces in to touching; the reef burtons and reef tack

will now haul out easily. Haul taut topsail halyards, lee braces, lifts, trusses, and rolling tackles, and haul the topsail buntlines well up out of the way of the men on the lower yards. If a becketed topsail, the fourth reef earing hauls out before the yard, as the others; with pointed topsails, that earing is passed abaft the yard.

As with four reefs in the topsails it is always good to keep the sheets eased off some four feet, they may be hauled up thus far when the reef tackle is being hauled out; but if the yards are well laid, the sails will be both quicker and more easily reefed if the practice of entirely clueing up top sails for a third or fourth reef is dispensed with. Of course when courses are set the topsails must be differently handled. After reefing courses the leech and slab line blocks will require to be shifted further out. It is recommended to haul the sheets of courses aft first, and haul the tack down, letting the yard go forward at the same time; but if there is option, it is preferable to get the topsail up while lifting, the lift taut, and then draw the lower tack down, easing braces, trusses, and rolling tackles to liking; bearing in mind that as the lee foremost topmast shrouds should not be too much pressed by the lee quarters of the topsail yards, there is no good object gained in bracing lower yards quite up. Under such sail as this there is generally much motion, and the chafe in the nips of the stays, as well as in the wake of sharp up yards, is beyond the power of protection from any description of service or scotchmen.

A head sail should always be set, and great care should be observed whilst taking in reefs that the ship is not taken aback. Moving the yards for the purpose of trimming sails, or indeed for any purpose, when the men are on them, is most perilous; for the foot of the topsails will sweep the lower yards, and the lower yards themselves be for a time quite adrift.

REEFING TOPSAILS AND COURSES.

These evolutions are sometimes performed at the same time, but when there is much motion, it is considered more Ship-shape to defer reefing the courses until the top-sails are reefed and reset. By so doing, the ship is kept more steady whilst the people are aloft.

Lower Yards should be well placed before sending men on

them for the purpose of reefing or furling courses. When i becomes necessary to perform either of these operations at se there is generally considerable motion; and an attempt to remed neglect or want of judgment in this particular, by handling th braces whilst men are on the yards is always attended with grea danger to them — especially in the case of main-yard men, wh are mostly composed of inexperienced hands — for the yards o becoming released from the nip of the stays, lee-rigging, an trusses, will not only "sally" from side to side, but scend vio lently fore and aft.

Whilst getting a pull on the tacks of courses, petty office frequently make use of a bad habit of letting go the lower lift thereby exposing the yards to great risk of being sprung unt again supported by these ropes. It should be remembered tha the object aimed at is not to pull the weather yard-arm down but to tauten the weather leech; and this is not effected b merely getting the tack block nearer the bumpkin or chesstree If the yard is already in a horizontal line, the lift should be kep fast, the bowline let go, and the luff of the sail made taut b putting a tackle on the tack.

When it is proper to slack the lower lifts, whilst gettin tacks down, the topsail lifts, top bowlines, and lee main brac (if taut) should also be slacked off at the same time.

As in securing a lower yard under a press of sail, a pull o the weather brace slacks the truss, and a pull on the weathe truss slacks the brace, it is advisable to haul these ropes tau together.

TAKING IN A COURSE.

The most proper way to take in a course during heavy weathe has been a matter of controversy ever since the times of th Great Harry. Until then, the yards were lowered on the dec when it became necessary to take in the sail.

In hauling up the weather clue garnet first, the weathe yard-arm, released from the downward pull of the tack, an bent upwards by the bellying canvass of the course and drag o the topsail sheet, is in great danger of being carried awa underneath in the nip of the stay: moreover, as the bulk of th sail goes bodily over to leeward the instant the tack is let go, i

is not properly embraced by the bunt and leech lines. When all the gear is hauled close up, there remain one or two balloons on the lee side, which, throwing themselves backwards over the yards and furlers as the ship comes nearer the wind, and then leaping forward bursting with wind as she falls off, are not to be controlled in any other way than sending men to the yard arm by the lift, and making them work from thence inwards with the sea gaskets.

When it is determined to haul up the weather gear first, the sheet should be slacked off short of splitting the sail by shaking heavily; and then all the lee gear hauled well taut before starting the tack. In this way the lee leech and buntline will grip the sail nearly at their proper places, and the difficulty we have alluded to be partially diminished.

In hauling the lee clue garnet up first, the canvass is gripped by the leech and buntlines to *leeward* of their natural place in the first instance; and then, by their pulling inwards as the sail is clued up, the canvass that would otherwise have been slack is stripped of wind, and hauled in taut along the lee yard-arm. Whatever canvass may be left slack on the weather side after hauling up the weather gear, is blown into the weather side of the bunt, where it is steadied and bound against the mast and stay, and is easily secured.*

TAKING A TOPSAIL IN WHEN BLOWING HARD.

Excepting as to the tendency of the weather lower yard-arm to fly upward, which is chiefly owing to the pull of the topsail sheet, all that we have remarked upon the subject of taking in a course in heavy weather, applies to taking in a topsail.

If there be no course set below, and the ship be on a wind, round in the weather lower and topsail brace until the sail lifts.

* Falconer's often quoted maxim:

> " —— he who strives the tempest to disarm
> Will never first embrail the lee yard-arm,"

was, on his own showing, an innovation upon "long tried practice." The charm of the poetry must not be permitted to cover an error in seamanship, or shake our faith in a method which the author of the "Shipwreck" terms "*barbarous.*" A soldier (and consequently a sailor) is no more exempt from saying a foolish thing than a man of letters.

Let go the halyards and lift-jiggers, clue the yard down, haul taut and belay the halyards. If there are hands enough, and there be three or four reefs already in the sail, all the gear may be run up together; if not, haul up the lee first, then the weather. If the top-gallant sheets have been rove round the clues, as before described, they will bring all the slack sail taut along the yard. Belay the clue lines, and steady up the topsail sheets, braces, and rolling tackle before sending the men up to furl.*

Before the wind, there is often great difficulty in getting the bunt of the topsails secured for furling, and it is not unfrequent to carry away the buntlines in the attempt. When this happens there is every probability of the sail being split and lost, unless the ship be rounded to and the sail thrown aback. When the course may not be altered, steady the bowlines, overhaul the top-gallant mast rope down before all, send its end up abaft the sail, and make it fast to the cap, lash a snatch block to the topmast above the yard, score the mast rope in it, and haul up on the deck end.

If the Course be set, the lower yard cannot be braced in, and the topsail must be "spilt" by rounding in the weather topsail brace, and hauling up the lee clue line at the same time. When this is done, haul up the weather gear, lower and secure the yard for furling.

SENDING A TOPSAIL UP IN BAD WEATHER.

It has been recommended to send a topsail up in bad weather, through the weather side of lubber's hole, because the sail is thus prevented from flying to leeward. However well it may go up in this way, great labour is involved in getting it across the fore part of the top afterwards; and there is considerable risk of finding a "turn" in the sail upon hauling it out, in consequence of having bent the gear in so crowded a place.

Let us suppose the main topsail.—If on a wind, send the sail tackle and topsail buntlines down to windward before the main lift and main top, and abaft the main yard. Send the weather

* Topsails will stand very long in strong gales, if the sheets are kept well eased off and stoppered, but the nips must be frequently freshened.

topmast studding sail halyards down abaft the main lift. Hook the sail on clear of turns with the after side aft (the roping of square sails is always on the after side); toggle the buntlines, and then hitch their bights round the quarters of the sail on their own sides; bend the studding sail halyards round both legs of the sail. Sway the sail up, keeping it to windward steadily with the stud-sail halyards. When the setting strop is as high as the yard, pass a rope's end from the top round it and the topmast, so as to keep the middle seam of the sail amidships. Bend the reef tackles *over* the lifts; toggle the bowlines; shackle the sheets and clue lines; carry the ends of the head earings to the yard-arms; cast off the studding-sail halyards; haul taut the reef tackles: sway the sail well up, and pull up the weather buntline, so as to light that arm of the sail over the weather main lift.* Haul out the reef tackles, easing the sail tackle and buntlines down, until the sail is in a line with the yard.

SENDING A TOPSAIL UP REEFED.

Becketed sails are particularly convenient for being sent up reefed to any extent. Lay the head on the deck, after side downwards, and place the reef bands one by one according to the number of intended reefs on the head; pass the head robands through that number of rows of beckets, and hitch them to their own parts on their bights. If four reefs, bring the reef tackle cringles to the yard-arms, and make the sail up as before described, bearing in mind that the arms will be heavy; consequently, in making up, as much slack sail as possible should be gathered into the bunt.

When sails are sent up furled with the intention of being immediately set, the more clue there is left out the better, as sheet blocks are easier handled in the top than at the quarters of the yard. Moreover, a great portion of clue may be steadied out in sheeting home before cutting the setting strop adrift. If in haste with the sail, and it be a becketed one, haul the sail along the yard as before said, pass the points from the yard

* It must be well remembered that in carrying courses in such a breeze as would demand all this precaution, it would be the extreme of bad salloring to let go a lower lift for the purpose of clearing a sail.

through the beckets, following the lead of the robands, toggle them; secure the earings, and make sail at once: the head can be brought to afterwards.

Pointed topsails are sometimes sent up reefed in the foot; but it has been found best to tie the points round the head as if the sail were on the yard, then to furl as if on the yard, keeping the head clear all along.

UNBENDING SAILS.

In unbending sails, it makes a neat evolution to "furl from a bowline." Pipe "furl and unbend;" run the reef tackles nearly out, and the bunt will be quicker furled; stop the upper yard ropes out.

When the topsails and courses are furled, stop them up with their gaskets, and let them hang in a few small slip ropes. Cast off leech lines, reef tackles, slab lines, &c. Unshackle topsail sheets and clue lines, single the head earings, hook the sail tackles and stay whips to the setting strops. Guy the lower booms a little aft if they are out, else the fore sail will fall on the topping lifts; pull the sail tackles up enough to lift the bunt of the topsails off the yards, and to let the arms fall clear of the stays. Sway the upper yards, and ease in all earings at the same time; station the sails for sides, point the topsails on the side of the lower stay they are intended to pass, and then lower booms, upper yards, and sails together.

SHIFTING TOP-GALLANT MASTS.

The most important matter in shifting top-gallant masts hastily is, on receiving the heel of the down coming mast on deck, to slue the turns out of the mast rope; then to carry the heel aft, keeping it from turning, and laying it on the deck with the lightning conductor (or after side) upwards along side of the new mast, which should also be placed in like manner.

A leading man should be stationed on the deck sufficiently far forward to see that the mast rope is clear of turns above the top rim; and to hold each part above the lizard widely separate, whilst the bight and lizard are shifted to the new mast. In this way the rope is certain of being clear.

Two half hitches on the lizard, and the use of the preventer fid, should invariably be insisted on.

SHIFTING TOPMASTS.

In shifting topmasts, it saves time and avoids risk to work with two parts of the hawser rove through the live sheave hole, and a lizard for a mast rope. The lizard should be made with a smooth round thimble, seized into a stout piece of good rope, its ends being tapered as salvagee tails. These tails grip the mast underneath the hound pieces when it is lowered sufficiently, and they should be kept from slipping down by a lashing from them to the mast head.

When the mast is lowered until the cross-trees are near the lower cap, the length of surge that will be requisite for starting them is determined by the time they have been on the mast head as well as by the length of the mast. If its head be inside the lower tressle trees when the heel is landed on deck, there is no danger to be apprehended ; only it is well to place bundles of swabs or coils of working ropes, &c., underneath, so as to receive the heel in the event of the hawser breaking. If the mast head come short of the tressle trees, a long surge would be a risk. Generally speaking, a six feet surge is sufficient to start the cross trees ; but whatever may be the length agreed on, the cap shores should be in place, and their lanyards fast before giving it.

The surge is given by unreeving the top tackle pendant, stoppering the hawser at the bitts or leading block (overhauling enough of it for the purpose), then making it fast, and when "from under" aloft, slipping the stopper.

When the fid is out of the old mast, we may commence with the new one. Let us suppose it to be main, and on the starboard side. Run the mast aft, brace the main yard sharp up on the starboard tack, lash a runner block on the after side of the mast about three parts up from the heel, reeve the main jeers from the capstan through the leads, upper jeer block between the fork of the stays, through the runner and jeer blocks, bring the end down between the fork, half hitch it round the mast above the runner block, and hitch the bare end through the fid hole — this will prevent the block from slipping up. Heave the mast up, bearing the heel

well over to port to keep the head clear of the main yard, lower the heel down the main hatchway until the head is under the stays. It will now hang clear of the other mast, and be ready for pointing.

Meanwhile the old mast perhaps has been surged, and the lizard passed. Bear its heel into the starboard side of the main hatchway, and lower it until the head is under the stays, pull the head forward with the main-top bowline to keep it clear of the top rim. Heave up until the heel is clear of the coamings ; carry the heel aft with a mizen burton, and lay the mast on the deck. When the old mast has been hove up high enough for its last lower, the jeers may be taken to the capstan, and the new mast hove up and pointed when done with the old mast. Reeve the hawser in the new one, heave it taut ; off jeers, heave up, and when placing the rigging, reeve the preventer top tackle, and then fid the mast.

In sailing ships, the heel of the down coming mast may be landed in the hold, and left there until the work of the new one is finished. In fidding the new mast, it must be remembered how much quicker the double whip hawser is than the threefold and double whip top tackle ; and therefore, when the fid hole is abreast the lower yard, care should be taken that the capstan is worked very slowly, and the top tackle allowed a fair share of strain.

Were this evolution performed at sea, and there was much motion, the top-sail yard should be well secured athwart the fore part of the top, and the yard tackles hooked on the mast-head so as to steady it until pointed.

SHIFTING JIBBOOM.

In sending the new spar out, it is of the first consequence to keep the point well up, and single jib halyards are scarcely equal to this purpose ; if they carry away, the bowsprit cap will be wrung.

In most large ships the stay-sail halyards are rove double, and if that sail is not set, they answer well. The next resource is the sail tackle, and the only objection to its use is that a signal to bend or shift topsails or topsail yards, made whilst it was employed with the jibboom, would cause confusion.

The practice of leaving the flying jibboom quite out whilst shifting the jibboom is a mere harbour "trick," and as it has nothing to do with seamanship, we need not explain how it is done.

There can be no rules given for sending broken spars down. The first thing to be attended to is their being steadied and prevented from falling on deck, or tearing sails: the next, to sling and guy them clear of the gear. The cleverest thing of this kind that we have heard of, was in the case of a shivered top-mast, which, after being fished with small spars above the cap, was got safely down by sawing off the lower ends of these spars as the mast was lowered.

It is considered a useful addition to the usual arrangements for general quarters in steam ships, to pass stout "frappings" round the lower rigging on each side, so as to be able to gather it in, in the event of the fall of a mast. Such ropes hanging slack under water, would be very apt to entangle the paddle or screw.

RUDDER GONE.

Rudder bands were the origin of rudder chains. In ancient times vessels had frequently a rudder at each end, and in bad weather, the rudders were triced up, whilst the ship "drove;" being let down again when moderate. When rudders became hung as at present, the fastenings remained for the purpose of retaining the rudder when bumped off on the ship's grounding, and seamen made use of them for steering purposes when any injury befell the rudderhead. The possibility of this latter application has sometimes been overlooked; and not only have the fastenings on the rudder not been sufficiently far down, but common bolts inserted instead of a strong metal strap which should clasp a large portion of the after part. A few years since in a three-decked ship during a gale, the rudder-head carried away, and when tackles were put on the rudder pendants, the ring-bolts drew, and they proved to be but rag-bolts. As the gale abated, a large ring-bolt was driven into the after part of the rudder; to this the runners were brought from each quarter, and the ship was steered during a strong breeze and great swell into Malta Harbour.

In arranging the gear of the temporary rudder in a screw

ship, it would be necessary to take the guys through the screw aperture under the after bearing, and from thence up on their opposite sides. They should of course be well covered at the nip. When the guys lead to the quarters, they should be turk's-headed, so as to keep them clear of torn copper.

To steer with a cable. — Pay through a mid-ship stern port, nearly as much cable as is intended to be overboard. Lash a spar across the stern, having a large block at each end; middle a hawser round the capstan, taking three or four turns; lead the ends through the blocks on each side in the ports that are a little abaft the capstan, then through blocks on the spar, and make them fast to the cable, expending the spare ends inboard; then veer the cable out a little more. A party of hands on the capstan bars will now be able to guy the cable out on either quarter as desirable. The capstan will in fact do the duty of the wheel.

Some rudders weigh as much as ten tons. In shipping or unshipping them, the bolts over head should be clenched. By crossing the runners, the lashing blocks will look better into the rudder hole.

Rudder chocks should be driven in when heaving off after getting on shore, and they relieve the fastenings very much if used when riding in much sea.

LANDING THE RUDDER.

Reeve the runners and tackles; lash the runner blocks round the beams, over the rudder head, or hook top blocks to the bolts that may be there, Reeve the runners through them, and make them fast through the tiller hole. If a very heavy one, double them; put a buoy and rope on the rudder from outside; cross the purchases to the opposite sides of the deck. Lash the driver boom down; put a long tackle on it from the mizen-mast head for a preventer lift, and pull it and the standing topping lifts taut; lead a hawser through a block at the mizen-mast head, through another on the boom at the lifts, and put a running eye on the end with a slip stop-rope on the eye.

Lift the rudder out of the braces, opening the helm port that it may rise: fish the heel of the rudder with the hawser, and when it has caught, which it readily will below the lower pintle,

heave the heel up, lowering the head, until both are nearly awash. Place the boats on each side of the rudder; lash spars across their gunwale strake at the afterthwart and broadest part of the bow; chock the spars up from the keëlson and thwarts, and hang the rudder to them by slip lashings, remembering that the head is considerably the heaviest part.

If it has to be sent into very shoal water, put it on a raft of casks.

A propeller, gun, anchor, or other weight too heavy for one boat, can thus be carried by two.

SLACK LOWER RIGGING.

On changing suddenly from a frosty to a hot climate, the rigging "gives out" sometimes to a dangerous extent. This is increased by the rolling motion; and casting it loose for the purpose of setting up becomes a very critical operation, especially when there is not wind enough to steady the ship.

When it is decided to do so, the distance from dead eye to dead eye is taken with battens which are cut to measure, and the quantity to be taken down of each shroud is determined on and marked on its own batten.

Take one mast at a time; get up a good muster of luffs, salvagee strops, nippers, &c., and have a long tackle on each pendant.

Get top-gallant masts on deck, and the lower yards braced in so as not to press on the rigging that you are employed on, and have the sails furled on that mast.

Hook on to the lanyards of the two foremost pair of shrouds on each side; put the luffs on the others, all ready for their turn; station men to nipper, rack, ring down, attend battens, and secure lanyards; put the nippers and racking on slackly; look out for a still moment, slip the bights of the lanyards and run the shrouds down to the marks, heave the nippers and rackings taut; do not be particular about the orthodox way of securing the lanyard, hitch it instantly round the shroud; you can do that afterwards during another still moment, and so on.

The stays, if necessary, would of course have been set up previously.

In a breeze, if you could steady the ship on a wind, you would

take your lee rigging down to the marks, and finish that of the other side, after getting the ship's head round on the opposite tack.

SWIFTING IN RIGGING.

But occasionally the rigging is too slack, and the motion is too great to admit of its being started. In this case swifting in is the remedy.

Lash a spar horizontally fore and aft outside the rigging high enough up to insure the shrouds being clear of the nettings as much as possible, when pulled inwards. Lash a single block round each shroud where the spar crosses, and let its lashing include the spar. Secure corresponding blocks on each side of the deck as low down as may be; a spar outside and lashing through the ports are safest, for the side bolts can scarcely be trusted for this work. Weave a hawser from each side of the deck through the blocks on its own side and those on the opposite rigging, and set all four ends up and secure them simultaneously.

CUTTING AWAY MASTS.

If it be required to cut away masts, leave a few shrouds fast on that side towards which you desire the masts to fall.

CASTING RIGGING ADRIFT.

In casting loose to turn in rigging afresh, the weather should be very fine indeed, and water very smooth, when the whole is adrift at once. A sudden swell setting in, or a heavy squall coming on when every shroud was in hand, and topmasts perhaps on end, would endanger spars and seamanlike reputation.

TO GET A LOWER YARD DOWN INSIDE THE RIGGING.

Let us suppose the mainyard port side of the deck.

Unbend the sail, send booms down, unreeve the gear, reeve three parts of the jeers. Put a sail tackle on the starboard yard-arm from the topmast head, single the lifts, put a burton from the port yard-arm to the mast at the partners, or hook the port

yard tackle to the starboard side, and have long tackles from the fore and mizen masts overhauled ready for the yard-arms. Unsling, top on the sail tackle, haul down the port arm, lowering the jeers so as to clear the starboard top rim. When the port arm is down, hook the mizen tackle to it, haul on it, lowering the jeers, and attending the sail tackle. Hook the fore tackle under the mainstay to the starboard yard-arm, ease up sail tackle. A luff on the bunt will now guy the yard off to the side, when it can be landed as convenient.

It will be necessary with either yard to clear away a boom boat on the side the yard is intended to be laid on.

In sending this yard up from the deck, a tackle from forward will be necessary for the purpose of carrying the lower arm forward as the yard rises nearly up and down.

CLUB HAULING.

You might have lost your rudder, or be too near the land to admit of Wearing, or there is too much sea on to tack, and you want to get the ship on the other tack. If in soundings, lead the end of a stout hawser from the lee (suppose the starboard) side aft, outside all, and bend it to the ring of the lee anchor for a spring. The quick way to get this end forward is to send a hauling line rove through a lead on the cathead aft for it.

Take opportunity, when she is inclining to come to, to help her with the sails; and when she is about to stop, let go the lee anchor. This will bring her head to wind; tauten and hold on the spring, veer cable when you see her head going off to port, and haul the after yards. When you are sure of her, slip the cable, cut the spring, but do not be too quick with the head yards.

HEAVING DOWN.

When ships have sustained injuries in their bottom, and there are no opportunities afforded for docking, recourse is then had to *heaving down.* Tackles are brought from the mastheads either to the shore or some other vessel, and these being hove on, turn the bottom up out of the water. The following Tables supply us with a list of the nature and quantity of materials necessary in the operation, and the remarks are abridged by permission from the notes of an officer who was engaged in the heaving down of H.M.S. "Formidable."

A Scale of Blocks, Falls, Pendants, Strapping, Shrouds, &c., used

			Heaving Down Purchases. Blocks and Strapping Falls.						Lashing for Purchase Blocks.				Outrigger.		Gammoning Pendants and	
Class of Ships.	Number on Main-mast.	Number on Fore-mast.	Size of Blocks.	Size of Strapping.	Blocks, Upper Treble.	Blocks, Lower Double.	Size.	Length.	Upper Block, Salvagee.	Upper Block, Length.	Lower Block, Size.	Lower Block, Length.	Number on Main-mast.	Number on Fore-mast.	Number of Pendants.	Length of Pendants.
Tons.			*in.*	*in.*			*in.*		*in.*	*fms.*	*in.*	*fms.*				*fms.*
1700 and upwards	2	1	40 to 36	13½	3	3	10½ to 9½	139	7½	25	6	10	Lower Deck, 5. Main Deck, 5.	Lower Deck, 4. Main Deck, 4.	18	8
From 1700 to 1000.	2	1	36 to 30	13½	3	3	9½	130	6	20	5½	10	7	5	12	8
From 1000 to 500.	1	1	30 to 26	10	2	2	8½	106	4½	12	5	10	5	4	9	7
Under 500 Tons.	1	1	26 to 22	9	2	2	7½	106	4	12	4	10	4	3	7	6

The "Formidable" was moored head and stern off the careening wharf, and completely cleared out; hammock nettings removed; the partners of the fore and main masts on the main and upper deck taken up, and the ship prepared for heaving down on the starboard side.

Bulkheads were built on the main deck; one being at the fore ends of the skids, the other at the after, and another which extended across the front of the poop. The starboard lower deck ports were barred in. Scuttles closed and boarded over; main deck ports on that side, excepting the four between the bulkheads, closed, boarded over, shored from inside, and all

in Heaving Down the different Classes of H.M. Ships at Malta.

	Lanyards.		Mast-head Pendants.				Blocks and Falls for setting up Masthead Pendants, Stropping, &c.						Righting Tackle under Bottom			Righting Tackle Upper.			Shores for Mast	Shores for Masts and Lashings for Ditto.				
Size of Pendants	Size of Lanyards	Length of each Lanyard.	Size	Length, Main-mast.	Number on Main-mast	Number on Fore-mast	Size of Blocks Double Double Scored.	Number of Blocks Double	Size of Stropping.	Size of Falls and Length.	Toggles	Size of Tripping Cable on each Mast	Size of Pendant	Size of Blocks, Double	Size of Falls	Size of Blocks, Double	Size of Blocks, Single	Size of Falls	Equal to the Top mast of each Class	Number on Main-mast	Number on Fore-mast	Number of Upper Lashings on each Long Shore.	Size of Upper Lashings.	Number of Belly Lashing on each Long Shore.
in.	in.	fms.	in.	fms.					in.			in.	in.	in.	in.	in.	in.	in.					in.	
10	4½	6	14	22	10	6	20	36	7	in. 7 fms. 15	8	20	14	18	6	16	16	5		3	3	2	4½	3
9	4½	6	13	20	7	5	17	24	6½	in. 6 fms. 10	12	18	12	16	5	14	14	4½		2	2	2	4	3
8	3½	4½	12	19	5	4	16	18	½	in. 5 fms. 10	9	15	11	14	4½	14	14	4½		2	2	2	3½	3
7	3½	4½	9	16	4	3	14	14	1½	in. 4½ fms. 10	7	14	10	14	4½	12	12	4		1	1	1	3	3

were caulked in and payed. The starboard chain pump dills were plugged and covered, and the pigeon holes between the bulkheads closed up.

Five bilge pumps were rigged, two at the fore, two at the main, and one at the after hatchway; in the squares of which stages were erected for the working parties. The lower deck was scuttled abreast these hatchways to permit the passage of water from the orlop.

The masts were stripped of everything excepting the lower rigging, and fished on the fore and after sides, with single spars reaching from the lower deck to the tressle-trees. These were

lashed in nine places and wedged taut. They were supported on the starboard side by shores, the heels of which rested on elm planks in the water ways; the deck being shored up underneath. Of these there were three; the first reaching to within 6 inches of the tressle-trees; the second, one third lower; and the last, another third below the second; their upper ends being chamfered were lashed to the masts. The bellies of the masts were further supported by horizontal shores of 3-inch oak boards which projected from thence to the main shores, three of them butting on the first, and one on each of the others. The heels were also shored in the holds on the port side.

On the port side the masts were secured by out-riggers composed of balks of timber, which butting against the coamings and bitts, &c., projected through the ports. Of these the main had five on the lower deck 40 feet long and 2 feet in the square, and four on the main deck 35 feet long and 18 inches square. The fore had four on the lower and three on the main deck of similar proportions, and the outer ends were shouldered and cleated about 18 inches from thence for the rigging to butt against.

The out-rigger martingales were 8-inch rope, fitted with thimbles in their ends; their middle taken with a round turn over the ends of the spars and seized, and set up with lanyards; those of the main deck to chocks in the lower deck ports, and those of the lower deck to shackle bolts which were driven through the ship's side and forelocked.

The preventer rigging for the main mast consisted of eight shrouds and one pendant of 13-inch rope. The latter were fitted with a long and short leg, and an eye splice in the end of each. In placing them on the mast-head the long leg, which set up to the foremost lower deck out-rigger, was put foremost, the short one to the foremost main deck out-rigger. Two pair of shrouds were placed over the mast-head to form a bolster, then the purchase blocks, then the remainder of the shrouds; lastly, the pendant with a lashing eye. This rigging was pulled up by double 20-inch blocks, double stropt, the eye of the shroud being taken through the strop and toggled. The lower block strops went over the end of the outriggers, the falls were 7-inch. The fore-mast was secured just as the main, excepting that it had but one fish, and that was on the after side. The runners were carried forward on each mast to

support the stays. The mizen-mast was additionally supported by the long tackles.

The wedges being removed, the masts were steadied over against the port partners, after which the starboard rigging was tautened.

The purchase lashings were set up by the runner pendant from one mast-head to the other. The tripping cables were brought from the opposite side of the harbour, under the bottom, and secured through the starboard upper deck ports to the port side, one being forward and the other aft. The Fore Chains were broken downwards (although previously shored) by the pressure of the foremost of these cables when heaving down.

The heaving down occupied twenty minutes, and the ship was eased up once to set up rigging; on which occasion, it was found that the long shore of the main-mast had butted against and injured the tressle-tree.

When first down, the fullness of the buttocks caused the stern to rise so high as to be inconvenient for the workmen, therefore eighty butts were secured under and below the fore-chains before heaving down the second time. This had the desired effect of keeping the keel parallel, and enabling the repairs to be carried on at the gripe and stern at the same time.*

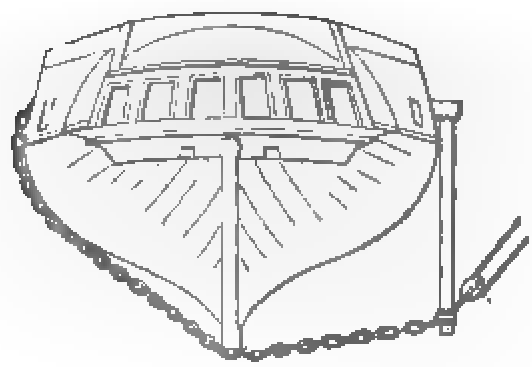
A very instructive lesson on this subject will be found in an account of the heaving down of the "Melville," published by Captain Harris. That officer remarks that the ship leaked when down as much as 268 tons in ninety-six minutes, although nine hand-pumps and five engines were at work all that time, a quantity which it took 210 minutes to pump out when righted; but that she leaked less when the main-deck ports, which we observe were open in the Melville and Formidable in the first instance, were closed. He also calls attention to the importance of preserving the original distance between the fore and main-mast heads, when setting up the rigging afresh; otherwise in heaving down, the masts spread apart, and the purchase falls do not look straight into their sheaves. In the case of the Melville's pumps, the lower ones discharged into tubs on the lower deck, into which the lower ends of the upper pumps were placed.

In cases where the vessel has been dismasted, or where it would

* It is well to nail battens fore and aft on the deck before heaving down, otherwise it is most difficult to pass along.

be impossible to procure sufficient length of purchase falls, &c., the bottom is turned out of the water by means of Spur derricks. H.M. ship "Success," for instance, was thus repaired. The upper ends of the derricks were cleated on the ship's side, the lower, to which the purchase blocks were lashed, were secured

Fig. 226.



from rising by turns of the chain cable, that were passed under the bottom from the opposite side, being steadied by guys led from forward and aft. (*Fig.* 226.)

CHAP. XXV.

STEAM ENGINE.

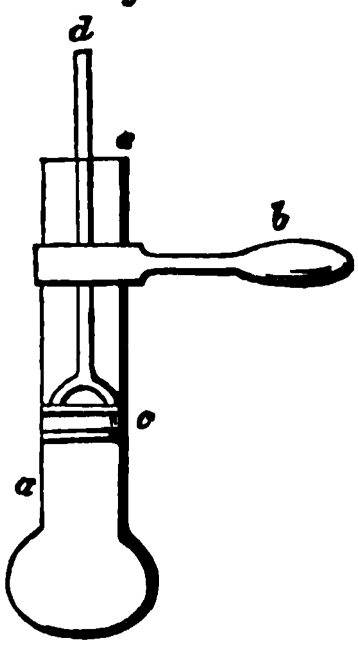
In this, as in other scientific subjects, our object is to excite a taste for inquiry and lead on to better books. It is, therefore, only pretended to give an outline of the general nature of the Marine Steam Engine, referring readers to those comprehensive explanations that have been published by more qualified writers.*

"The simplest view of the marine steam engine is to consider it as a propelling machine, moved by vaporised water. To turn

* Marine Steam Engine, by Professor Maine. Ditto, by Robert Murray, Esq Ditto, by Captain Robinson, R.N. Ditto, by Lieutenant Gordon, R.N.

water into vapour or steam there are boilers and furnaces. From the boilers steam passes to the cylinder, in which a piston moves, the piston (generally) carries a rod which works a crank, the crank turns a shaft, and the shaft a wheel or screw." *

Fig. 227.



The two leading properties of steam are its expansive force and its facility of condensation, both which are shown by the use of a glass tube as in the figure.

Let *a* represent a glass tube with a bulb at its lower end. It is held in a brass ring to which a wooden handle is attached, and contains a piston *c*, which (as well as its rod) is perforated, and may be opened or closed by the screw at top, *d*; it is kept central by passing through a slice of cork at *e*.

When used, a little water is poured into the bulb and carefully heated over a spirit lamp; the aperture in the piston rod being open, the air is thus expelled, and when steam freely follows it, the screw may be closed, when, on applying cold to the bulb (as for instance, putting it on the surface of a little mercury in a glass), the included steam is condensed, and a vacuum formed, which causes the descent of the piston, in consequence of the air pressing upon it from above.

On holding again the bulb over the lamp, steam is reproduced and the piston again forced up : and these alternate motions may be repeatedly performed by the alternate applications of heat and cold.†

The true nature of heat is not known ; it operates on solids by *conduction*, and on fluids by *connection*. In the former process it passes through the body without derangement of its particles ; in the latter those which are nearest the heat are displaced. "If heat be applied to a vessel of water, the particles near the bottom are heated first, and expanding become specifically lighter, and ascend ; colder particles occupy their space, and ascend in their turn, and thus a current is established." ‡

* Pamphlet by Admiral Fitzroy. † Brandt's Manual of Chemistry.
‡ Tomlinson, Nat. Phil.

Thus heat is conveyed throughout the whole volume of water, and, raising its temperature to 212°, it rises in the form of Steam.

It is evident that the more particles that can be brought under the influence of the heating power the sooner will Steam be raised. Consequently, Boilers are placed with their longest dimensions horizontally. Fire places are ranged along the bottom, and their flues carried sinuously through their interior, thus giving what is called a greater "heating surface."*

It is, moreover, necessary in marine boilers that, as a precaution against fire, the furnaces and flues should be contained within the boiler, being thus surrounded by water.

Heated bodies radiate heat more or less according to the nature of their surface ; the dark and rough radiating and absorbing more than those which are bright and polished ; hence it is that boilers, and frequently cylinders, are covered with wood or felt, &c.

Oxygen, as we have already shown, is the principle of burning, and one pound of coals requires as much as 240 cubic feet of air for its combustion. Hence it is, that if there be delay in clearing the stoke hole of ashes, or neglect of ventilation by windsails, removing hatchway gratings, &c., the fires get low, and then the steam.

The same consequences follow when the fires are only replenished at great intervals, and then so profusely as to retard combustion.

By good stoking is meant little at a time and frequent; and as this cannot be done without great toil, the ship will often move slowly, when a few spare hands lent from the watch would make more difference than shaking two reefs out with all hands.

So long as water and sufficient heat are supplied, Steam will be generated. When a fresh supply of water ceases, the remainder will be evaporated, the boiler become red hot (and consequently weaker) and burst with an ordinary amount of pressure; or gas might be generated and explosion occur. Therefore, all Boilers are fitted with Feed pumps, which are worked by the engine itself, restoring to the boiler as much of the water which has been used in condensing as may suffice.

* There are other reasons for this arrangement which are equally strong, but not so evident.

The necessary quantity to be admitted is determined by observing the level in the glass "Water Gauge," which is on the outside of the boiler—this level corresponding with that inside. The amount of supply is regulated by hand; and as it has necessarily become heated in the operation of condensing, its introduction in the boiler does not materially lower the temperature there.

The consequence of allowing the water level to get too high in the boiler is that it boils over into the steam pipe, and is discharged in the form of *priming*. Priming is also occasioned by insufficiency of steam space in the boiler.

We may notice, in passing, that in stationary Land Engines the boiler supplies itself by means of an inside float, which being suspended from a valve, communicates with a reservoir of water. As the water in the boiler is consumed, the float descending opens by its weight the valve, and admits a sufficiency. On attaining a temperature of 212°, the water does not acquire any more heat, although transmission continues; it passes into the steam, and there exists under the name of *latent heat*, to an extent which, judged from its effect—for it is not indicated by the thermometer—is roughly estimated at 1000°. It is this power of retaining a great amount of heat, that makes steam so useful in raising quickly the temperature of water into which it is thrown, as in the case of baths and buildings heated by pipes.

"A cubic foot of boiler will heat about 2000 of space in a cotton mill to about 70° or 80°, and one square foot of surface of steam pipe is adequate to the warming of 200 cubic feet of space."

Steam, like air, is elastic, and if generated in a close vessel may be retained until compressed into an elastic force, which needs be restricted only by the strength of the boiler. This force is measured by the amount of its pressure in pounds on every square inch in the surface of the piston, or that of the surface which contains it; and is indicated by the *Steam Gauge*, which is a bent iron tube, partly filled with mercury, and placed vertically on the front of the boiler, into which its end opens.

At a temperature of 212°, its elastic force is equal to that of the atmosphere, and it will therefore support a column of mercury 30 inches high: at 230° it will support 42 inches, and so on.

The mercury in this tube will of course be at the same level in both its branches when the steam in the boilers and the

atmosphere press equally, but will rise in the longer leg as the pressure of the steam increases, and will thus by its rise indicate the amount of that pressure. If the elastic force of steam were suddenly to increase, the mercury would overflow or be blown out altogether, and thus this gauge would become an additional safety valve.

At whatever pressure steam may be generated, it requires the same quantity of fuel to evaporate a given volume of water. Hence it is economical to use high pressure steam.

The evaporative power of coal is dependent on the quantity of carbon it contains; Welsh is superior to Newcastle, and all coal is superior to wood as one to three.

A quarter of a pound of good coal will produce 25 cubic feet of steam, which is equal to one horse power.

"Patent fuel is a mixture of coal and other substances. Its object being to combine great evaporating power, with freedom from sulphurous or other noxious qualities, with durability in form and nature, compactness for stowage, non-liability to spontaneous combustion, or generation of gases, and economy; a combination of qualities possessed by no one kind of coal."

Boilers are usually made sufficiently strong to resist a pressure of 100 pounds on the square inch.

When engines are of such size as to require more steam than can be supplied by one boiler of ordinary size, additional boilers are placed side by side, communicating their products through one pipe, which is common to all.

There is, however, a limit to size inasmuch as the liability to bursting increases with extent of surface; and it is for this reason that large boilers are sometimes made with an internal series of tubes in which the steam is generated, these separate compartments communicating with a common steam reservoir of great strength.

To remedy the ill effects of deposit as much as possible, a portion of the boiler water is blown off occasionally by means of a cock at the bottom.

When steam is raised from boiling water, it occupies 1800 times as much space as the water from which it is raised. When first generated, its force is that of one atmosphere; at 320° it is equal to five; at 356° to ten, at 416° to twenty, at 590° to one-hundred atmospheres. One cubic inch of water converted into

steam, will produce a mechanical force sufficient to raise a ton weight a foot high.

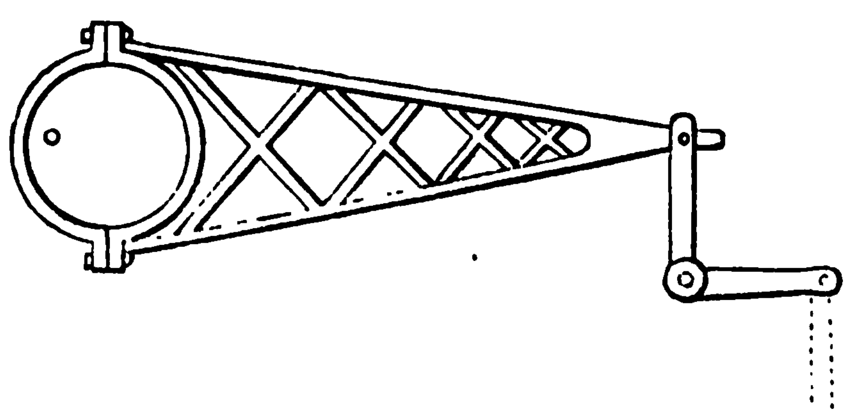
So great a pent up force naturally suggests danger, and provision is made in the *Safety Valve*, for the escape of steam when it exceeds the pressure which the boiler is calculated to resist. On this occurring, the valve, which is suitably loaded, is raised by the superabundant force of the steam itself; and when the steam has become diminished to the required pressure, it closes.

Vast as is the force of steam, it is the most controllable of all the motive powers; for having performed its duty of urging the piston through the cylinder in whatever direction the engineer determines, it is led off into a separate chamber, the condenser, and deprived of its energy in an instant. Heat gave it being; cold resolves it into its former condition of water. Two ounces of water will in a second condense 200 inches of steam, and reduce their expansive force to one fifth.

In a double acting condensing engine, as a ship's, when the steam has acquired a certain amount of strength, it is permitted to issue through the steam pipe; and is discharged in jets alternately above and below a moveable piston working in a steam-tight compartment—the Cylinder—escaping from thence into the Condenser by the Eduction pipe on one side of the Piston, while it is active on the other.

This arrangement is effected by a system of openings or passages, which are regulated by the engine itself, through the instrumentality of a wheel having its axis on one side of its centre, called the Eccentric (*fig.* 228.). Those passages which admit are

Fig. 228.



the steam, and those which emit are the exhausting, passages. The slide valves which close these passages act in concert;

so that, for instance, the lower exhausting and upper steam passages are open, whilst the upper exhausting and lower steam ones close simultaneously. A vacuum more or less complete is formed on one side of the piston, while the entering steam presses upon the other with nearly an unopposed force.*

By means of a contrivance called the *Expansive Gear*, the movement of a valve in the steam pipe is so managed that the admission of steam to the cylinder is "cut off" at certain points of the stroke of the piston. For water is sometimes carried with the steam into the cylinder, accumulating at its bottom; and were the piston permitted to "travel" the whole length of the cylinder, it would come in contact with this incompressible accumulation, and produce fracture.

Moreover, by the use of this gear, the steam is economised when desirable. The slides being set with reference to the strength of the steam, the admitting aperture is closed at a particular moment when the piston is moving, and the remainder of the stroke is effected by the expansion of the steam which has just been admitted.

On its arrival in the adjoining chamber (called the *Condenser*) the steam is received with a cold shower-bath, the supply of water for this purpose being admitted through the Injection valve, from a pipe which communicates with the sea, by means of a Kingston's valve in the ship's bottom. This supply is regulated by a Sea-Cock at the bottom, and an Injection cock near the Condenser.†

The steam, being re-converted to water, is made to flow along with that used in condensation, through the foot valve, towards the air pump which carries it to the *Hot Well*, from whence the quantity necessary for replenishing the boilers is conveyed by

* The apparatus for admitting and shutting off steam from the cylinder called the Throttle Valve is usually worked in the engine room. The evil consequences of having no means on the upper deck for stopping the supply were shown in the case of a merchant ship not very long since. A fire having broken out in the engine room, gained so rapidly, that the engineers had to desert that quarter of the ship; and when it became desirable to stop the vessel for the purpose of lowering the boats, it was found to be impossible, and she steamed furiously ahead until almost the moment of sinking.

† High pressure engines are not furnished with Condensers, Air pumps, or Waste pipes, the steam that has operated on the Piston being allowed to escape into the air.

the action of the hot-water pump back again to the boiler, the residue being forced overboard through the waste water pipe. All these different valves and pumps, excepting the Kingston valves in the ship's side, are worked by the engine.

The piston rod works through a steam tight collar in the lid of the cylinder called the stuffing box; and as it always must of necessity, when thus arranged, move in a line with the cylinder, whether that vessel be horizontal or upright, some contrivance is required by which its linear motion may be converted into the circular which is demanded by the Paddle or Screw. The cylinder must either be adapted to the motion of the rod, or the motion of the rod to that of the double handles called cranks, which turn the shaft. In the first of these cases, the cylinder is made very much in the form of a great Howitzer, and pivots in like manner on the trunnions. These are bored through, and thus steam is admitted. The head of the rod is connected immediately with the crank, and thus, this beautifully simple and compact arrangement becomes a "Direct acting oscillating engine." By placing two such engines beside each other, and fixing their respective cranks at different angles on the shaft, one is always actively carrying the other past the centre of the axis, or through what is called the *Dead point;* whilst the other is in its neutral position.

In some engines, where the cylinders are fixtures, the motion of the rod is kept in the line of its cylinder by the parallel motion, and is communicated to the crank by an intermediate system of side-rods, side-levers, and connecting rods, or by making the piston hollow as in Trunk engines. In the case of a Side Lever Engine, the rod is fitted with a cross which forms, as it were, the shoulders; from these hang the arms, the side-rods, grasping the ends of the great handles, the side levers, or sway beams, at the extremities of which, rise the connecting rods that turn the cranks.

One Engine on each side of the ship working cranks differently set, as before described, turn over the Dead point, and excepting the parallel motion, which we leave as matters for personal investigation, we have but to inflate the lungs of the machine to produce rotatory motion.

Trunk Engines are always direct action ones, and may be comprehended by conceiving the piston rod to be very much

larger in diameter than usual, projecting (steam tight) through both ends of the cylinder, and hollow, having a connecting rod, one end of which pivots in the centre of the piston or trunk, and the other turning the crank.

Fig. 229. represents a Trunk cylinder engine, as seen from the fore part of the engine room.

Fig. 229.

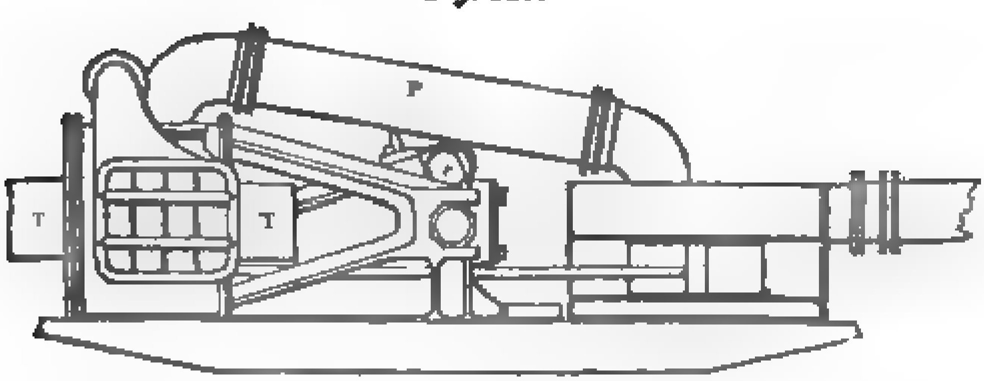
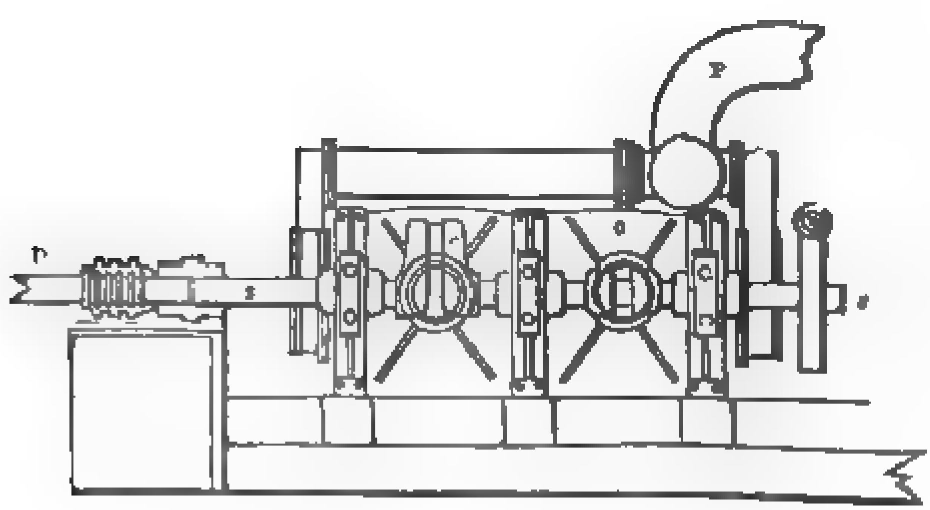


Fig. 230. is the same engine as seen from the port side.

Fig. 230.

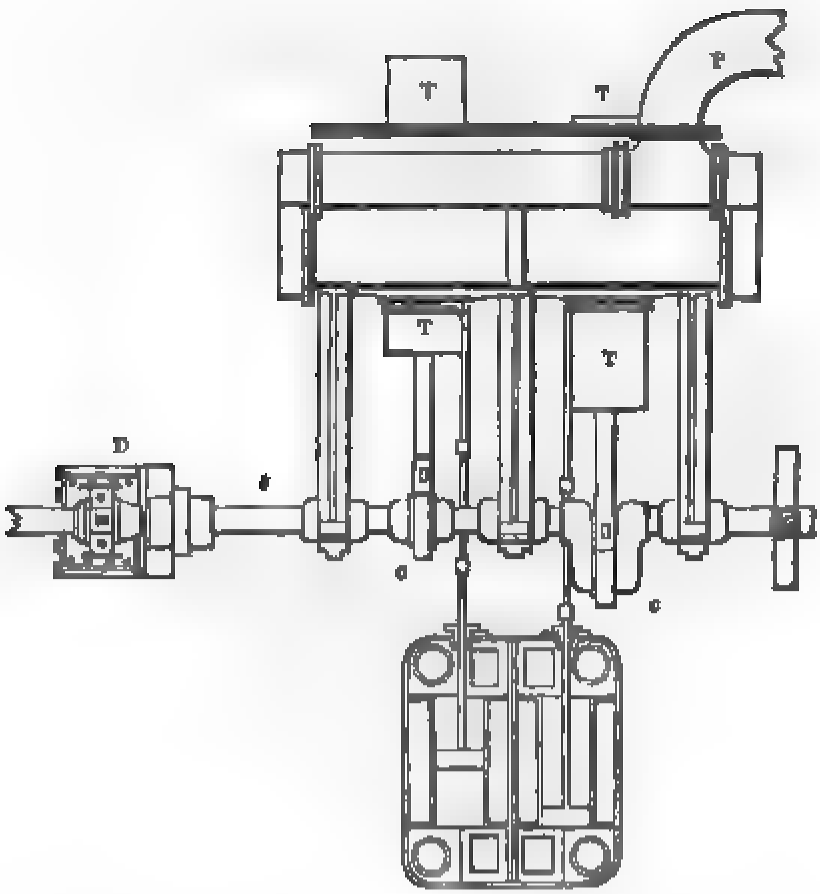


D. Coupling and bearing.
P. Steam pipe
T. Trunks.

c. Crank.
s. Shaft.

Fig. 231. is the same engine as seen from the deck.

Fig. 231.



With a single engine, such as we have on shore, the dead point is disposed of by means of a great balance wheel having a heavy rim, which is placed on the end of the main shaft. This wheel, receiving motion in the first instance from the engine, absorbs a certain amount of moving force, by which it *carries its way* through this critical moment, and regulates the speed of the engine by its uniform motion. "A force of fifty pounds per second, imparted to a loaded wheel, will so accumulate as to enable it to overcome a resistance of nearly 500 pounds in ten seconds." The necessity for this balance wheel in the case of but *one* land engine, and its inapplicability to marine purposes, will serve to explain why two engines are required in a ship.

The resistance to a marine engine varies. For instance, when a ship plunges her wheels in the water, the resistance is great, and the revolutions few. Again, when a ship pitches heavily, the screw is at times more than half out of the water,

and the resistance small, so that we require some contrivance by which a supply of steam, varying in proportion to the resistance, shall be supplied to the cylinder with a view of preserving it, or its gear, from the consequent danger of rupture. This is effected by the *Throttle Valve*, which is placed in the pipe that conveys steam from the boiler to the cylinder. In ships this valve is adjusted by hand from time to time, and during very heavy motion, requires constant manual attendance; but in land engines, it is worked by an apparatus called the Governor, which deriving motion from the engine makes the latter self regulating in this respect. When the steam is thus partially checked, it is said to be *wire drawn*.

Whilst the power of the machine may be measured by external symptoms, such as length of stroke, and pressure of steam on the gauge, &c., there is a mode of ascertaining what is going on in the very heart of the cylinder itself; for it must be borne in mind that the efficiency of the entering steam will be dependent on the completeness of the vacuum on the opposite side of the piston.

The more dense and powerful the steam, the greater quantity of water will it be composed of, for low pressure steam is but a small quantity, and high pressure is but a larger quantity of water and vapour; therefore, the stronger the steam the more active should be the condensing apparatus, and if it be not doing its duty as well as the boiler, the vacuum will be indifferent, and the great force of steam neutralised. Now by attaching an instrument called the *Indicator* to the main cylinder, we have a tell-tale which, regulated by the internal condition, supplies us with a self-written report in the form of a diagram, not only of the performances of the steam, but also of the extent of vacuum.

The Indicator has been called a steam Stethoscope, and may be said to tell the condition of the spirit of that imaginary monster which seems to lie fettered and obedient at the bottom of a great ship. This little instrument may be applied to the cylinder, boiler, or other places; a minute hole only being required to admit steam when it is fixed. It is a very small cylinder in which is a piston bearing against a spiral spring, and carrying a pencil, pressing lightly upon a paper attached to a roller which revolves as the piston moves, having a line attached

to the machinery. One stroke is made as the piston goes each way, and the result is a complete figure or diagram, traced on the paper, which shows very nearly how the engines are performing, and afterwards, when carefully measured and calculated, what is the actual power, exerted by the steam. This index affords not only a measure of the whole power, but also shows the power exerted at each part of the stroke.

"The height at which the pressure of the atmosphere solely would keep the pencil of the Indicator, is shown by a line drawn across the paper by the pencil while influenced only by the atmosphere. The length of the figure is divided into equal parts by any convenient scale, and the pressure of the steam above the line, and below (which might be called exhaustion) is measured by the scale to which the indicator is divided; one-tenth of an inch usually representing one pound pressure on a square inch. Then mechanically, with compasses, a certain number of equi-distant ordinates are measured, and their mean length taken, as representing the average pressure on the piston during one stroke. This mean pressure multiplied by the velocity of the piston (or the number of feet travelled by it in a minute), and again by the area of the piston in square inches, gives a product which, divided by 33,000, gives the indicator horse power, or indicated power of the engines."

This indicated power is seldom less than twice the *nominal* or contract power of the engines.

As it has elsewhere been shown that *Weight* and *Time*, and *Height*, or *Distance*, are interchangeable with each other, it will easily be understood that it becomes a convenient mode of expressing the power of a man, or a horse, to say that one man or one horse can raise a given number of pounds one foot high in one minute, inasmuch as multiplying by one, does not change the figures.

A horse power is reckoned at 33,000 pounds raised one foot high in one minute, this having been found by experiment to be about the amount of work actually done by a good horse of average strength. To measure the horse-power of a steam engine, it is necessary to know the total number of pounds pressing continuously, or rather on an average, upon the piston, which is the amount of weight to be moved; and also the

velocity with which this weight is being moved, or the distance through which it travels in one minute.

The former is found by multiplying the area of the piston by the average pressure of the steam upon each square inch ; this average having been either found by the Indicator, or assumed from a knowledge of the pressure of the steam as generated in the boiler and used in the engine.

The distance through which the piston travels in a minute is found by multiplying the length of stroke which it makes in going from one end of the cylinder to the other, and back again, by the number of such strokes made in a minute. The total pressure on the piston of any engine, and the velocity or total distance travelled by the piston in one minute being obtained or known, the *power* of that engine is then calculated as a common rule of three sum.

Thus: As 33,000 lbs. multiplied by 1 foot high in 1 minute (which represents one horse power) is to the total pressure in lbs. on the piston, multiplied by the velocity of the piston in feet in 1 minute, so is 1 horse power to the horse power of the engine as sought.

In speaking however of an engine generally, the *length of stroke* is the distance travelled by the piston, from the top to the bottom of the cylinder, or *vice versâ*, and not a whole stroke, or the distance from a starting point back again to that starting point, which is equal to a revolution of the crank.

The duty of an engine is the amount of work done in reference to the quantity of fuel consumed. The Modulus or useful effect of a machine is the fraction which expresses the amount of work compared with the power applied, which is expressed by unity. Thus if the work performed be only $\frac{2}{3}$, the other third would have been lost in friction, and the actual product $\frac{2}{3}$ would be the modulus.

The consumption of fuel is computed at 8 lbs. per horse power per ton. The capacity of coal boxes at 48 cubic feet to the ton.

The cost of engines varies from 20*l.* to 60*l.* per horse power, according to the intrinsic value of the materials used.

An engine of 450 horse power, weighs on an average, altogether, about 300 tons. Thus, for example :—

Weight of engines	- - - -	50 tons
„ boilers	- - - -	97 „
„ water in ditto	- - -	56 „
„ propeller gear	- - -	50 „
„ copper pipes	- - -	5 „
„ coal boxes *	- - -	5 „
„ stores and spare gear	- -	24 „
		287 „

THE SCREW.

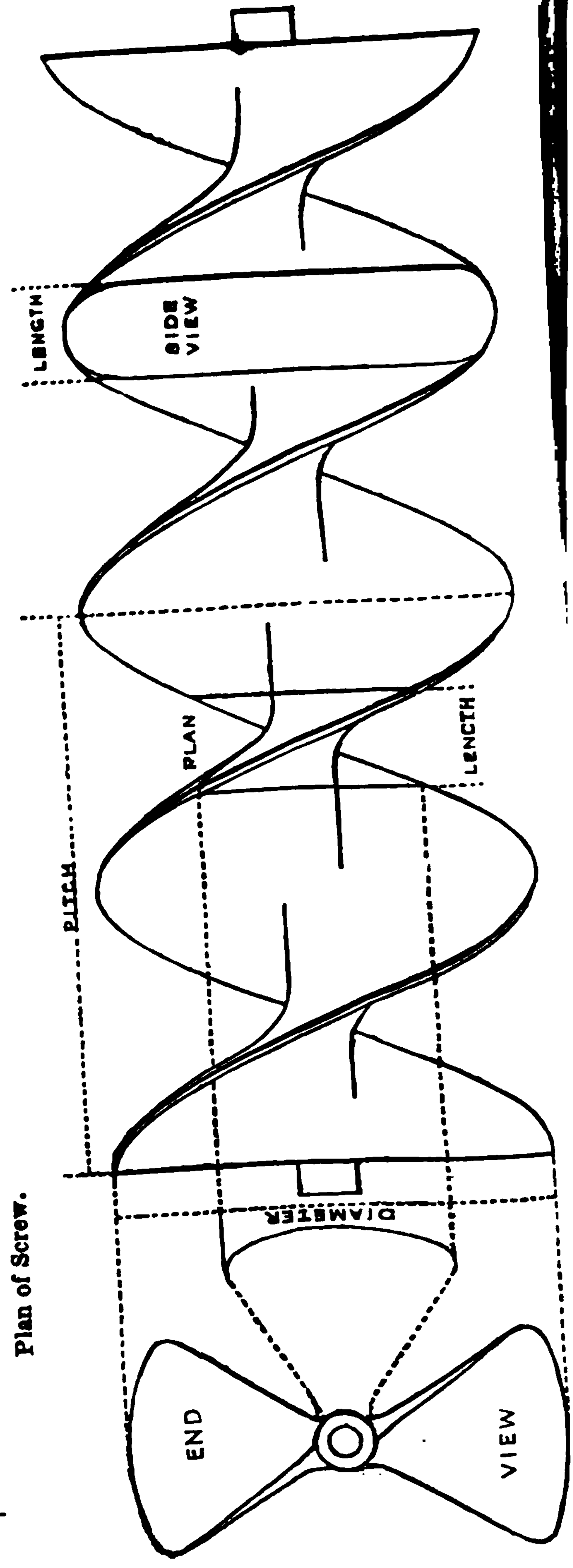
The Marine Propeller is a screw placed on an axis parallel to the keel, having its thread more or less inclined to the perpendicular. Turned in one direction it bears against the water and the vessel; the water offering the greatest resistance, the vessel recedes and is moved ahead. Turned in the opposite direction its tendency is to draw the water towards the ship; but again the water asserts its superiority, the ship follows the screw and goes astern. When the screw is tried in the basin, the ship's bows bear against, and are secured to, the wall. The ship then of course becomes the fixture and the water the body that moves. The enormous power of the screw is never seen to greater advantage than during this experiment. The scene presented by the agitation of the water in this struggle for supremacy reminds a spectator of the eddies and convulsions of a maelstrom, and he is inclined at some moments to fancy that either the vessel will break up under the pressure, or the strong opposition of stone blocks themselves be forced to give way. The propelling action of the screw, unable to project the ship, flings the water astern with tremendous force, and the opposite action, after straining the bow fastenings to the uttermost, expends its force on the water, which it draws towards the stern in rapid and tumultuous currents.

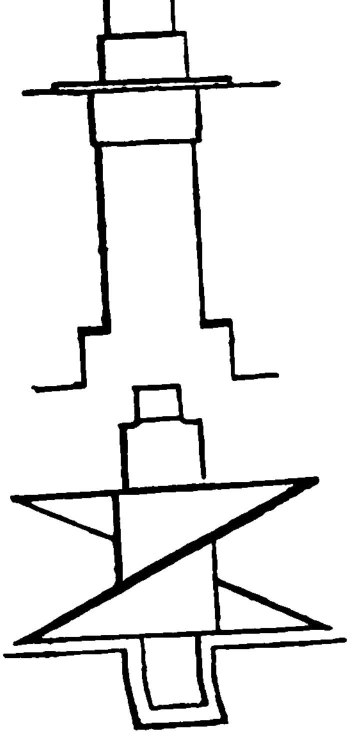
The annexed figure will probably convey a better idea of the propeller than can be gathered from a mere description. In this piece of a screw there are two threads, and it is evident there might be more or less. But as the propellers used in the navy are generally two threaded, that is the class represented here.

* These contained 220 tons of coal.

Fig. 232. is a two-threaded screw; a section of which, as at "plan" or side view, would form a sketch of such a propeller as is generally used in the navy.

Fig. 232.

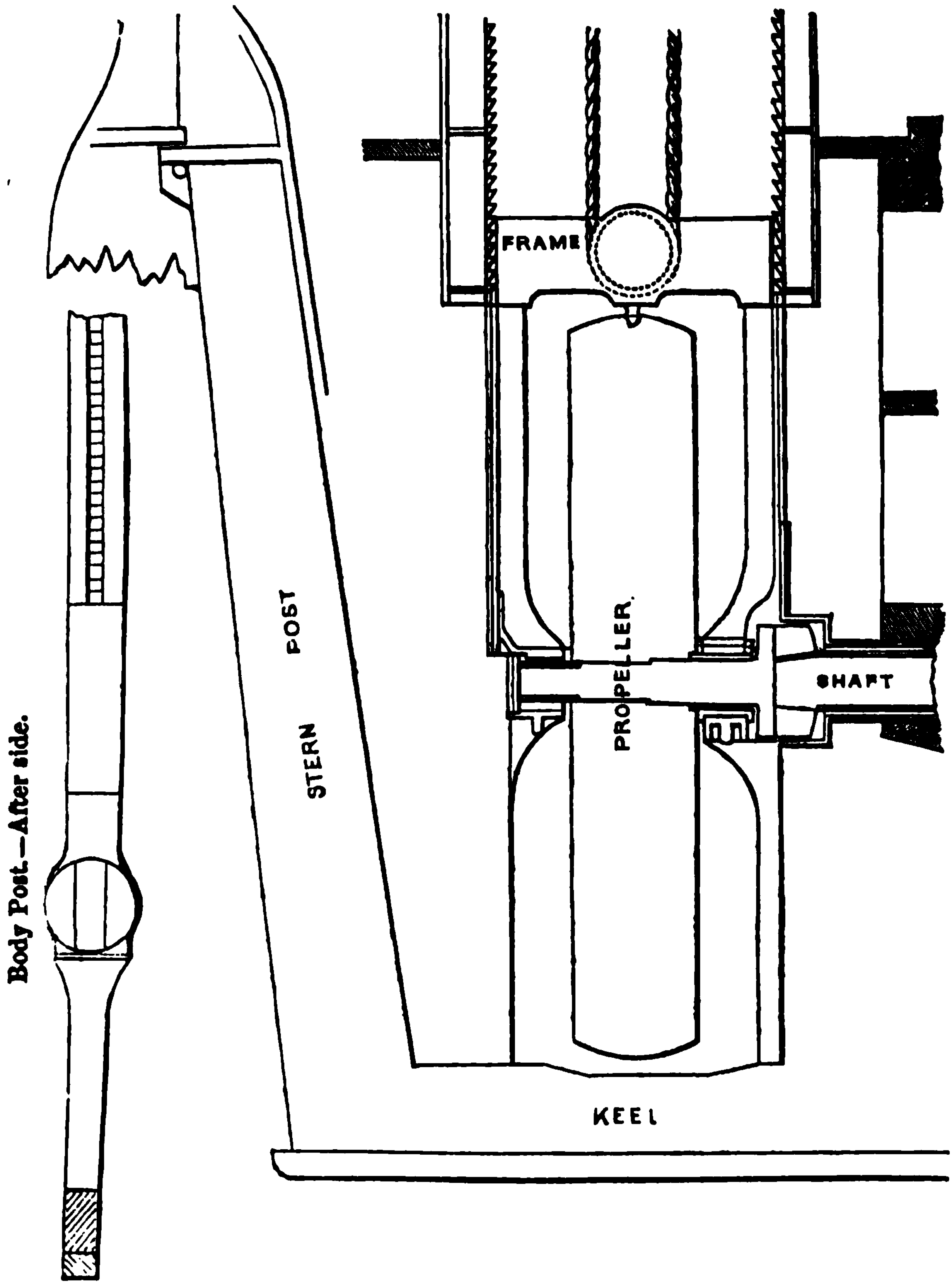




Plan of Screw.

Fig. 233. represents the propeller in its frame, on its bearings, and connected with the shaft.

Fig. 233.



A propeller cut out of a screw of this kind, would appear end on and sideways, as in the sections.

It must be observed that a propeller is cast in the form of a section, and not cut out of a great length of screw. The length is merely drawn for the sake of illustration, because a section alone is not very readily comprehended.

The mode in which the propeller is suspended in its frame, by which it is raised, lowered, and supported in its place by bearings, and by which it is connected with, and disengaged from the driving shaft are shown in the drawings.

"The pitch of a screw is the distance in a straight line, from one point of the outer line (periphery) to the point that completes one spiral turn around the axis or shaft, or it is the distance that a screw advances in a solid by one turn.

"During its revolution the propeller does not advance the whole distance of its pitch as is the case of a screw entering a solid substance; because the water yields to some extent. This deficiency of progress is called the slip."

HANDLING THE PROPELLER.

When the Propeller is heavy in proportion to the yards, place the main yard, lash the bunt particularly well, put on the lee rolling tackle, pull up the lifts, trusses, &c. Have two top tackles and their pendants as in the first way described of getting in guns; use the main jeers rove in the upper and spare jeer blocks for an up and down tackle; also, have two preventer tackles to separate strops on the yards for lifts. They must be from the cap, but the ends of the pendants should, after going over the cap, come on deck and be secured there. It is not impossible to wring a mast head. If you have to carry the screw aft, land it on an 8-inch gun carriage.

In dealing with the mizen mast, as in getting the screw on the poop from the quarter deck, or lifting it out of the chamber, the greater rake of the mast and shortness of howsing demand considerable support from forward, and it is a matter of opinion whether the runners and tackles should do so from the mainmast head or the deck.

To lift the screw into the banjo and place it on the racks in the chamber, make a derrick of the spanker boom, stepping the

jaws on a chock on the deck, filling up the hollowed out part, and supporting it from the mizen mast head.

Chain reeving lines for screw pendants do not last so well as rope; if they should unreeve by accident, the fish hooks seized in the ends of the pendants will catch the frame and bring the screw up.

DISTILLING APPARATUS.

The great space occupied by the Engine, Boilers, and Coal-Bunkers in Steam ships, interfering so much with the stowage of the usual quantity of fresh water, it has been found necessary to provide for a sufficient supply, by means of Distillation, — a process that may require explanation.

Whatever substance may be held in solution in water, whether earthy, vegetable, or saline, it does not enter into the vapour or steam which is generated by boiling; and as Steam or Vapour may be reconverted into water by exposure to cold, we have only to collect it in a condensing apparatus, from which the water may be drawn off in a pure state. It is true, that the water which has been mentioned as returning to the boiler from the engine condenser is so freed from salt as to be perfectly fresh, but having gone through so many greasy passages, it is unfit for drinking purposes. A separate chamber is therefore connected with the boilers into which the waste steam, or steam raised for the purpose is admitted, condensed, or distilled, and finally drawn off in the form of purest water.

Fig. 234. represents the condenser with one side removed, showing the internal arrangement, by which the distilling apparatus will be seen to consist of a rectangular tank with two pipes leading into one side of it, one at the lower part, marked "entry," being for the purpose of admitting cold water, and the other at the upper end, and marked "exit," for the purpose of allowing the water admitted through the lower pipe to escape. By means of these pipes, in a manner which will be hereafter shown, a continual current of cold water is kept passing through the condenser ; and issuing from the top will be seen a small pipe, marked "vapour exit," the use of which will be hereafter explained; these form the detail of the outer compartment shown in our diagram. Still referring to *fig.* 234., the inner compartment is seen to consist of two small chambers, one placed

above the other at some distance apart, and connected by a series of metal pipes or tubes; and rising from the upper chamber, passing through the outer compartment before mentioned, is a pipe marked "steam," which connects to the steam boilers of the ship; also, issuing from the lower chamber is a small pipe which passes through the outer compartment at the lower end, and from which fresh water is shown to be running.

Having now gone over the outline of our diagram, we proceed to show the action of the various parts before named, during the process of distilling fresh water from the sea. The steam from the boilers enters the steam pipe leading to the upper chamber of the inner compartment (*fig.* 234.), where it expands as shown by the arrows in our figure, filling the tubes before mentioned, and is there rapidly condensed (returned to water) by the contact of the cold sea water, which has flowed in through the entry pipe, filling the outer compartment, and surrounding the external surfaces of the tubes and inner chambers. The water thus distilled falls into the lower chamber, and runs from thence through the small pipe, marked "fresh water," into the tanks.

Fig. 235. represents the external appearance of condenser when closed and ready for placing in a ship.

Fig. 234.

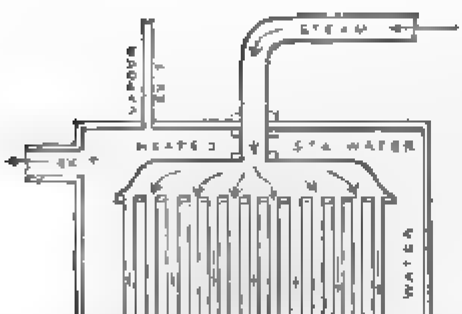


Fig. 235.

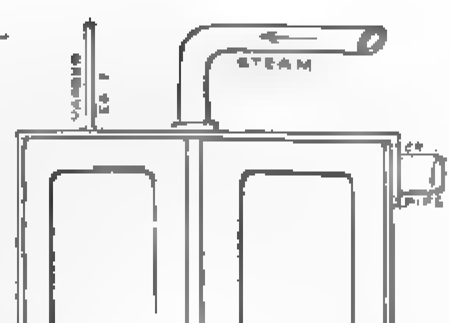
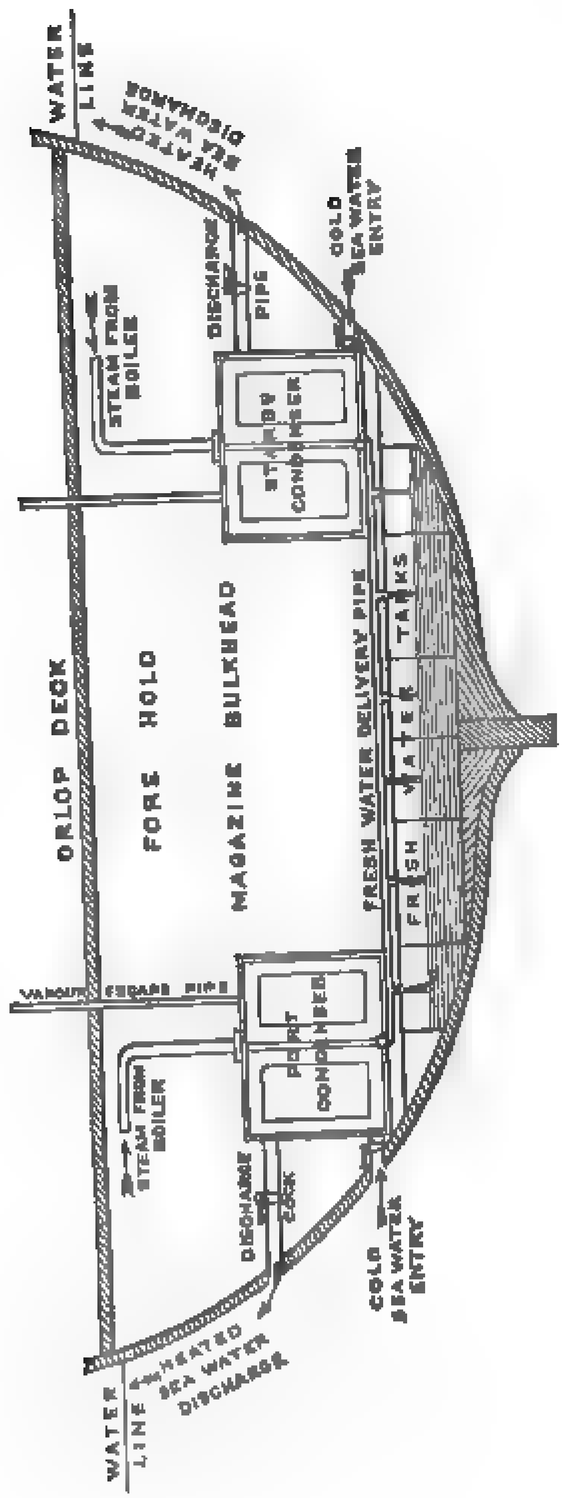


Fig. 236. By applying our former remarks to this figure we shall see how the distilling apparatus is placed in a ship. The figure represents the fore hold of H.M.S. "Royal George,"

Fig. 236.



Fore Hold of "Royal George" fitted with Condensers.

where two of these condensers are fitted, one being on each side of the ship. By looking at this figure, we see that the before named entry and exit pipes pass through holes in the ship's side, and thus open a communication between the condensers and the sea; therefore, the condensers being placed below the water-line, the cold water has a free passage into the outer compartment, where, from being in contact with the tubes of the inner vessel containing the steam, it becomes heated, and hot water being lighter, bulk for bulk, than cold, it rises to the surface of the sea, passing through the upper pipe marked "exit," and thus a continual current of cold water is passing through the outer compartment of the condensers, carrying off the heat which causes the steam in the inner chamber to return to water. We have now to explain the use of the small pipe, marked "vapour escape." The heated water emits a vapour which, if an escape passage were not provided, would accumulate, and in a short time rise to a sufficient pressure to resist the entrance of the cold sea water through the lower pipe. The vapour escape pipe is therefore fitted to the top of the outer part of the condenser, and carried above the water line inside the ship, so as to allow this vapour to escape into the atmosphere. It will also be observed in the diagram (*fig.* 236.) that there are cocks in each of the exit and entry pipes, for the purpose of shutting off the communication with the sea when the condensers are not at work.

Condensers of this description are made of the various sizes adapted to different classes of ships; those fitted to the "Royal George" are capable of distilling 40 tons of water in 24 hours, and this is obtained at the rate of the expenditure of 1 ton of coals for 7 tons of water.

APPENDIX.

A few remarks on the personal outfit, expenses, &c., of a Naval Cadet may be of service to candidates.

The following price list of articles necessary for a cadet's first equipment may be taken as a fair sample of such estimates. Some of the prices are less than those charged by outfitters generally; and, as the compiler of this one seems to have given general satisfaction, we may assume that the articles are good, and the prices sufficiently remunerative.

		£	s.	d.
1	Registered Improved Iron-bound Sea Chest, No. 3637., with Improved Zinc Wash Tray & Foot Bath - - - - - - - - -	4	10	0
1	Not Registered, from - - - - - -	2	10	0
1	Dress Coat, Vest and Trowsers - - - - -	5	5	0
1	Superfine Uniform Round Suit - - - -	3	10	0
1	Second Cloth ditto - - - - - - -	3	5	0
1	Double-breasted Blue Waistcoat - - -	0	14	6
1	White Cashmere ditto - - - - - -	0	14	6
6	Indian Jean ditto, at 7*s.* 6*d.* - - - - -	2	5	0
1	Watch Coat and Trowsers - - - - - -	3	10	0
1	Summer Cloth, or Cashmere Jacket and Waistcoat	2	2	0
1	Patent Waterproof Coat, Leggings, and Goloshes	2	6	6
1	Blue Flushing, or Pilot Reefing Jacket - -	1	14	0
6	Pairs Russia Drill Trowsers, at 10*s.* 6*d.* - -	3	3	0
12	Imperial Military Duck, at 9*s.* - - - - -	5	8	0
6	Unbleached Scrubbing ditto, at 7*s.* - - -	2	2	0
	Dowlas, or Linen Jackets - - - - - -			
6	Cotton or Merino Drawers, 3*s.* to 5*s.* - - -			
6	Flannel or Merino Shirts, 3*s.* 6*d.* to 5*s.* - -			
24	Cotton Socks, 8*s.* 6*d.* to 10*s.* 6*d.* - - -			
6	Worsted ditto, 1*s.* 3*d.* to 1*s.* 6*d.* - - - -			
36	Shirts, with Linen Fronts, Collars, and Wrists, 3*s.* 6*d.* to 5*s.* - - - - - - - - -			
6	Baltic Flannel Shirts, 8*s.* 6*d.* to 12*s.* 6*d.* - -			
6	Night Shirts, at 3*s.* 6*d.* - - - - - -	1	1	0

		£	s.	d.
12	Linen Collars, 7s. 6d. to 10s. 6d. - - - -			
12	White Cambric Pocket Handkerchiefs, 10s. 6d. to 15s. - - - - - - - -			
6	Coloured Cotton, ditto at 9d. - - - - -	0	4	6
6	Silk ditto, at 2s. 6d. - - - - - - - -	0	15	0
4	Black Silk, for the Neck, at 3s. 6d. - - -	0	14	0
3	Pairs Sheets, at 6s. 6d. - - - - - -	0	19	6
6	Pillow Cases, at 1s. - - - - - - -	0	6	0
24	Towels, 8s. 6d. to 10s. 6d. per dozen - - -			
4	Table Cloths, 4 yards each, 2s. to 3s. per yard -			
2	Regulation Caps, Mohair Bands and Ornaments, 20s. to 22s. - - - - - - - -			
1	Silk Oilskin Cover, for ditto - - - - -	0	2	6
1	Covered Hat, 2s. 6d. to 3s. 6d. - - - - -			
1	Dirk, Belt, and Gold Knot, 2*l.* 15s. to 3*l.* 3s. -			
1	Leather Dirk Case - - - - - - -	0	4	6
1	Hair Mattress and Pillow - - - - - -	1	2	6
1	Feather Pillow - - - - - - - -	0	7	6
3	Blankets - - - - - - - - -	1	2	6
1	Counterpane - - - - - - - -	0	5	6
1	Set of Clues and Lines, mounted - - -	0	3	6
2	Hair Brushes, 2s. to 3s. 6d. - - - - -			
2	Combs, at 1s. 6d. - - - - - - -	0	3	0
4	Packets of Soap, at 1s. - - - - - -	0	4	0
2	Nail Brushes, at 1s. 6d. - - - - - -	0	3	0
3	Tooth Brushes, at 1s. - - - - - -	0	3	0
1	Clothes Brush - - - - - - - -	0	2	6
1	Set of Blacking Brushes - - - - - -	0	4	6
6	Cases of Blacking - - - - - - -	0	3	0
1	Improved Quadrant or Sextant, from 1*l.* 16s. to 4*l.* 10s. - - - - - - - - -			
1	Box of Mathematical Instruments, from 10s. 6d. to 1*l.* 1s. - - - - - - - -			
1	Telescope and Signals, from 2*l.* 10s. to 3*l.* 3s.			
1	Dr. Inman's Navigation and Tables, new edition -	1	0	0
1	Parallel Ruler and Gunter's Scale - - -	0	7	6
2	Nautical Almanacs, at 3s. - - - - - -	0	6	0
3	Logs, at 2s. - - - - - - - -	0	6	0
3	Watch bills, at 1s. 6d. - - - - - -	0	4	6
	Books, Stationery, &c. - - - - - -			
2	Pairs of Braces, at 2s. 6d. - - - - - -	0	5	0
1	Set Metal Wash Fittings - - - - - -	0	10	0
1	Portable Desk or Writing Case, from 12s. 6d. to 1*l.* 12s. - - - - - - - - -			
1	Duck Clothes Bag, with Name painted - -	0	5	6
6	Pairs White Lisle Gloves, 8d. to 1s. - - -			
2	Kid ditto, 2s. to 3s. - - - - - -			

	£	s.	d.
2 Warm ditto lined, 2*s.* 6*d.* to 3*s.* 6*d.* - - -			
1 Carpet Bag, from 5*s.* 6*d.* to 10*s.* 6*d.* - - -			
1 Set of Silver Spoons and Forks (according to number required by Mess) - - - -			
1 Looking Glass - - - - - - - - -	0	3	6
1 Leather Case, fitted with Silk, Thread, Buttons, &c.	0	6	6
1 Neck Shawl, Cashmere - - - - - -	0	5	6
2 Pair Boots - - - - - - - -			
3 Pair Shoes - - - - - - - -			
Engraving - - - - - - - -			
Spare Uniform Buttons and Rings - - -	0	7	6
1 Brass Plate, Name engraved for Chest - -	0	2	6
Waterage - - - - - - - -			
Porterage - - - - - - - -			
1 Sponge and Bag - - - - - -	0	5	6
1 Scrubbing Brush - - - - - -	0	1	0

Registered chests differ from those hitherto in use, in being more expensively finished, and having drawers. Drawers are objectionable; inasmuch as midshipmens' chests must be frequently carried on the upper deck of lighters when "taking a passage," and of small craft when clearing the lower deck. In a lee lurch, or heavy rain, the drawers in the ground tier of the registered chests are filled with water; moreover, in clearing the holds, the chests in the cockpit are frequently so blocked up as to be inaccessible except at the lids. A good sea chest, with wash fittings complete, should not cost more than 3*l.*

In well regulated messes, the table cloths are purchased as part of the mess equipment, and a small advance on the entrance money for this purpose is well bestowed; otherwise much valuable room is taken up by the stowage of these articles in the chest. When soiled, they are unfit for a place among clothing, and consequently are always to be found either mouldering in the "scran bag," or being used as knife cloths in the stewards' pantry.

The best pattern for telescopes is Ross's 1½ foot glass; it should be fitted with a strap and signal card. A new edition of "Inman's Tables" has recently been published, which costs 1*l.*

Spoons and forks must be silver, not plated; and are more easily identified by initials than by crests.

The rising extravagant habits, which threatened to supplant the old-fashioned frugality and manly indifference to epicurism,

have been so promptly checked by the Authorities, that it is needless to do more than quote their Circular on the subject.

"[Circular No. 282.]

"*Admiralty*, 12*th December*, 1856.

"(*Expense in Messes of Her Majesty's Ships.*)

"My Lords Commissioners of the Admiralty have lately had reason to believe that much greater expense has been incurred by the Messes of Officers in some of Her Majesty's Ships than is sanctioned by the Rules and Custom of the Service; and, from complaints, which have been made to their Lordships, that mess debts have not been liquidated at the proper time for payment by the Officers contracting them, and claims have consequently been made upon Officers, who were subsequently appointed, to subscribe for the discharge of debts to which they had given no sanction:

"My Lords have to call the attention of the Officers of the Fleet to these irregularities, in order that they may be avoided in future; and their Lordships desire that the Officers of the Ward Room will adopt such measures as will enable their Messes to be maintained with credit and comfort, and free from extravagance, and thus set a becoming example to the junior Officers.

"In regard to the Gun Room Messes; my Lords have on several occasions had brought to their notice circumstances of extravagance and mismanagement, which have been caused by the unnecessarily high subscriptions, and the use of expensive wines and spirits, totally at variance with the custom of the Service and the pecuniary means of the Officers.

"With a view of putting a stop to such irregularities, my Lords direct that the subscriptions to the Gun Room Messes shall never exceed the sum of *eight* pounds for entrance, and that the monthly subscriptions, including all extras, shall not be more than *thirty* shillings.

"Their Lordships further desire that no wine, except port and sherry, or wine of the same class and price, and no spirits, except the ship's allowance, be used in the Gun Room Messes.

"No wine, spirits, or beer are to be received on board any of Her Majesty's Ships without the written approval of the Officer in command.

"Their Lordships have also been led to believe that, in some of Her Majesty's Ships, Messmen, under the designation of *Stewards*, are still permitted to carry on the sale of provisions, wine, spirits, &c., to the Messes of the Officers as well as to the men, in direct contravention of the Admiralty Order of the 30th May, 1851. The attention of the Officers of Her Majesty's Ships

is called to this subject, as nothing can tend so much to irregularity in a Mess, as well as to injury to the discipline of a ship, as to permit any person to make a traffic by the sale of provisions, spirits, &c., instead of the Messes being properly conducted by their caterers.

" The Commanders-in-Chief and Senior Officers in command of Stations are hereby directed to take the necessary steps for carrying out these Orders.

" By Command of their Lordships,

" R. OSBORNE.

" To all Flag-Officers, Commanders-in-Chief,
Captains, and Commanding Officers of
Her Majesty's Ships and Vessels."

In this circular it is not intended that wine expenses should be included in the " thirty shillings." The custom of the service, as gathered from very numerous mess statements, admits of ten shillings a month as being a sufficient sum wherewith to cover a youngster's wine bill.

The publication of this much desired Circular elicited some remarks in a leading journal, which were so very apposite, that we are led to reproduce them.

" We notice with satisfaction a very opportune order of the Admiralty restraining the mess expenses in the navy. In the army, navy, Universities, and wherever youth forms a society of its own, youth has to be protected against itself. This battle has been now fighting in the Universities for years, and with very moderate success. . . The Admiralty, however, will probably be more successful as they command the approaches, and have their young men within more convenient limits. . . . It is altogether a more manageable affair. Even the Admiralty, however, will probably find that it is much easier to issue orders on this subject than to get them observed. Were it simply, however, a matter of good eating and drinking which the Admiralty or the Universities, and all authorities that have masses of young men committed to them, had to contend with, the battle would not be so difficult. But it is more than this ; it is a particular idea and standard of what is the fine thing to do — it is juvenile ambition and high spirit. . . . Youth has a horror of plebeianism, and a taint in that quarter is a perpetual spring of shame and remorse.

should have the means of keeping up their kit, and affording recreation. What the extent of those means should be, has never been officially determined, but a large majority of experienced officers who have been consulted on the subject, agree in thinking 2*l.* a month sufficient. It is, however, desirable where it can be afforded, that the captain of the ship should have a discretionary power to exceed this sum, when places and objects of interest cannot be visited without incurring greater expense than the regular allowance would admit of. The customary mode of supplying the funds agreed upon has been, with the captain's consent, to lodge them in advance in his agent's hands, the captain endorsing bills as they became due. By this arrangement the captain is exposed to a certain amount of risk, but this he will generally incur rather than that his youngsters should be moneyless. We may confidently expect that whilst so much is being done for the benefit of these junior officers, some official or less precarious method of supply will soon come into operation.

The necessary Qualifications for the entry of Naval Cadets, &c., have been recently set forth by their lordships in the form of a circular, so that we have but to place that statement within reach of our readers, and to express a hope that in our endeavour to show them "round the ship," we have offered them some slight assistance towards the fulfilment of their duties.

ADMIRALTY CIRCULAR ON QUALIFICATIONS OF NAVAL CADETS.

[Circular No. 288.]

Admiralty, 23*rd February*, 1857.

(*Naval Cadets — Midshipmen, &c.*)

The Lords Commissioners of the Admiralty have established the following Regulations for the Entry of Naval Cadets, and for the Examination of Mates, Midshipmen, Naval Cadets, &c., which will come into operation in May next, instead of those now in force.

To qualify an officer to receive a Lieutenant's Commission, he must have attained the full age of nineteen years, and have been borne on the Books of, and actually served in, one or more of Her Majesty's Ships not less than five complete years, eighteen months as a Cadet, and three years and six months as a Midship-

man, and shall have passed such Examinations as the Lords Commissioners of the Admiralty may from time to time direct.

I. No Person will be nominated to a Cadetship in the Royal Navy, who will be under thirteen, or above fifteen years of age at the time of Examination.

II. Every Candidate, on obtaining a nomination, will be required to pass an Examination at the Royal Naval College at Portsmouth, within three months of nomination.*

III. The Candidate must produce a Certificate of Birth, or Declaration thereof made before a Magistrate.

IV. The Candidate must be in good health and fit for the Service, that is, free from impediment of speech, defect of vision, rupture, or other physical inefficiency.

V. Candidates, between the ages of thirteen and fourteen, will be required,

1. To write English correctly from Dictation, and in a legible hand.

2. To read, translate, and parse an easy passage either from a Latin or French Author.

N.B.—The aid of a Dictionary will be allowed for these Translations.

And to have a satisfactory knowledge of

3. The leading facts of Scripture and English History.

4. Modern Geography, in so far as relates to a knowledge of the principal Countries, Capitals, Mountains, and Rivers. To be able to point out the position of a place on a map when its Latitude and Longitude is given.

5. Arithmetic, including Proportion, and a fair knowledge of Vulgar and Decimal Fractions.

6. Algebra, including Fractions.

7. The First Book of Euclid to Proposition XXXII. inclusive.

Candidates above the age of fourteen, in addition to the Examination required for those between the ages of thirteen and fourteen, must have a knowledge of—

1. The use of the Globes, with correct definitions of Latitude, Longitude, Azimuth, Amplitude, and the other Circles of the Sphere.

* NOTE. These Examinations will take place on the first Wednesday in the Months of February, May, August, and November.

2. Vulgar and Decimal Fractions.
3. Algebra, including Simple Equations.
4. The First Book of Euclid.
5. A practical knowledge of the Elements of Plane Trigonometry, and its application to the Numerical Solution of easy and useful Problems.

As Drawing will prove a most useful qualification for Naval Officers, it is recommended that Candidates for the Service should be instructed therein.

VI. If the Candidate succeeds in passing the required Examination, he will be at once appointed to a Training Ship at Portsmouth or Devonport, for a period of not less than three months, for the purpose of instruction in the subjects contained in Sheet No. 1., as well as in the Rigging of Ships, Seamanship, the use of Nautical Instruments, &c.

VII. Quarterly Examinations will be held on board the Training Ship, when any Cadet, who may consider himself competent, may be examined in the subjects contained in sheet No. 1, also in the course of instruction, in the Rigging of Ships, Seamanship, &c., and if found qualified he will be appointed to a sea-going Ship.

VIII. If the Cadet does not pass the required Examination according to his age, before or at the quarterly Examinations after his entry into the Training Ship, as below specified, he will be finally rejected from the Service.

Age at the time of his entry in the Training Ship.	Quarterly Examination after his entry in the Training Ship.
14 years 6 months - - - -	2nd
14 years and under 14 years 6 months -	3rd
Under 14 years - - - - -	4th

Or if a Cadet by indifferent conduct or idle habits on board the Training Ship shall show his unfitness for the Service, it will be the duty of the Captain to make a special report thereof to the Admiralty, in order that the Cadet may be at once removed from the Navy.

IX. No Cadet will be allowed to reckon more than three months of the period of his service in the Training Ship, towards his future Sea Time.

X. When a Cadet shall have served the full period of eighteen

months, including the three months' time in the Training Ship, he will be eligible for the Rating of Midshipman, provided he passes the following examination, in which it is to be ascertained —

1. That he has kept up a knowledge of his former instruction.

2. That he is able to work a Day's Work by Tables as well as by projection, to find the Latitude by observation of the Meridian Altitude of the Sun, Moon, and Star, Longitude by Chronometer, and to work an Amplitude.

3. That he understands and can explain the use of the Sextant, and Azimuth Compass, and the mode of observing with them. At each Examination the Candidate will be required to show that his Sextant and other Instruments are in good order.

4. He must produce Log Books kept by himself from the time of his entry into a Sea-going Ship, and Certificates of good conduct.

5. He will also be required to have a fair knowledge of steering and managing a boat under Oars and Sail, of Knotting and Splicing, Rigging Lower Masts and Yards, &c., the use of the Hand and Deep Sea Lead, and also the Simple Exercise of the Great Guns.

XI. All Midshipmen, until they shall have passed their examinations for Lieutenant, are to keep a book in which the ship's reckoning is to be worked out and noted, and when they are at sea this book is to be sent in every day to the Captain, instead of the slip of paper containing a day's work, which is now usually presented. It is also to be produced at their examinations; and during the last six months of their service as Midshipmen it must contain the working of the Observations as given in Sheet B.

XII. A Midshipman when he shall have served eighteen months in that rank will be required to pass an intermediate Examination. In addition to the subjects embraced in former Examinations he will be required to have —

1. A good knowledge of practical Navigation, showing that he understands the principle of Navigating a Ship from one distant port to another, by Dead Reckoning and by his own Observations; and that he can explain the principles of the

same ; and that he can also take and work a double Altitude and Azimuth.

2. A sufficient knowledge of the Chart as will enable him to place thereon the position of the Ship by Observation as well as by Cross Bearings; and to lay off the True and Compass Courses.

3. Such knowledge of Nautical Surveying, as may enable him to measure a base line and determine positions by angles, and the manner of ascertaining heights and distances.

4. If he has served in a Steam-Vessel, an acquaintance with the different parts and working of the Steam Engine.

5. A proficiency in French.

6. He must be a fair practical observer.

7. He must produce Log Books kept by himself from the time of his entry into a Sea-going Ship, and Certificates of Good Conduct.

8. He will likewise be examined as to his progress in the knowledge of rigging of Masts, Bowsprits, &c , in getting tops over and placing a lower cap, in setting up rigging, and especially as to the precautions required in staying lower Masts; in hoisting a quarter or stern boat up in a strong breeze with a Sea on ; in making up a course and topsail for bending at Sea ; in shifting topmasts, yards, and sails at Sea, and the effect of the sails on the Ship both in tacking and wearing; in the detail arrangements for mooring and unmooring Ships and getting under-way. He must likewise know the Great Gun and Small Arm Exercise, the use of Tangent Sights, the charges for the Guns of the Ship, and be able to Exercise the Men at his Quarters. A report of the progress he has made in each of the above subjects is to be made to the Secretary of the Admiralty in the Half-yearly Return.

XIII. The Examinations under Articles X. and XII. are to be conducted by the officer in command, not below the rank of Commander, and the next Senior Officer in the Ship, and the Examinations in Navigation, in the presence of a Captain or Commander, by two Naval Instructors when it may be practicable, or by a Naval Instructor and a Master, or where there is no Naval Instructor by two Masters, that in Gunnery by a Gunnery or other competent Officer ; and at these Examinations the Candidate is to be made to take and work out his own observa-

tions for Latitude, Longitude, Variation, &c., as the case may be. 1st or 2nd Class Certificates are to be given according to the merit of the Candidate, in the Form A, or he is to be rejected if found incompetent.

XIV. A Midshipman, when he shall have passed the Examination referred to in Article XII., must continue to serve in that rank for a further period of two years; and having completed such two years, he may, if he has attained the age of nineteen years, present himself to pass his Examination for the rank of Lieutenant, in accordance with the Forms Nos. II., III., IV.

XV. The Examination for the rank of Lieutenant is to be conducted before three Captains or Commanders, by order of the Commander-in-Chief or Senior Officer of two or more ships present together; but a Midshipman, having completed his term of service, and being nineteen years of age, who is serving in a ship or vessel so far separated from other ships that the foregoing Regulation cannot be complied with, may be provisionally examined by the Captain or Commander of such ship or vessel, with the aid of other competent Officers — Lieutenant, Master, or Second Master, and if they find him to be duly qualified, they are to give him a certificate to that effect, dated on the day of such examination, and the Captain may forthwith give him an acting order as Mate; but he must be re-examined on the first opportunity that shall afterwards offer by three Captains or Commanders, as before required, and if he passes successfully, he will receive from the Commander-in-Chief, or Senior Officer, an acting order as Mate to take rank according to the date of the first certificate.

As the above is the final Examination in Seamanship, the Examining Officers are to be most strict in their investigation of the qualifications of Officers, and they are to see that everything required by these Regulations has been complied with by the Candidate, and that he produces Certificates of good conduct from Captains he has served under for five years.

XVI. All Midshipmen and Acting Mates will be required to undergo the following final Examinations —

1. In Gunnery — On board the "Excellent."

2. In Navigation and the Steam Engine — At the Royal Naval College.

Acting Mates who have already passed abroad are to present themselves for Examination on board the "Excellent," at the first Examination Day after their arrival in England, or after being paid off, and having passed in Gunnery, they are then at liberty to select either the 1st, 2nd, or 3rd Examination Day at the Royal Naval College.

XVII. Any Officer rejected on his first Examination at the College will incur the forfeiture of three months' seniority in his rank as Mate. He may present himself on the next Examination Day, but a second rejection will incur the forfeiture of three months more seniority; he may again present himself on the next Examination Day, but a *third rejection* will cause his name to be removed from the List of the Navy.

XVIII. Officers when they have passed their final examination at the Royal Naval College, as provided for in these Regulations, will be confirmed from the date of their first Certificate.

The non-appearance of an Officer for Examination at the Royal Naval College at the times required by these Regulations will be considered as an acknowledgment of his not being qualified, and he will be dealt with in the same manner as if he had been actually rejected on each day on which he may have omitted to appear, unless under certified ill-health, to be duly reported at the time.

XIX. Naval Instructors are to keep a School Journal or Register, which is to be produced when required by the Captain of the Ship or the Examining Officers, and the Captain is to allow them reasonable access to the charts and chronometers, for the purpose of instructing the Officers in their use.

XX. The Examinations under Articles X. and XII. are to commence with those Officers who shall enter the Service after May, 1857, and the final Examination at the Royal Naval College, required by these Regulations, is to commence in August, 1862; but any Midshipman, previous to that date, when he may have completed five years' service, and who shall have attained the full age of nineteen years, may present himself for final examination in Seamanship, Gunnery, and Navigation, in accordance with the foregoing Regulations, instead of having to serve six years as now required; but if he fails in passing his *first* Examination he will not be allowed to come up for re-examination until he has completed his six years' service.

XXI. — With reference to Circular No. 58, of the 17th December, 1849, — The final Examination at the Royal Naval College, established by the foregoing Regulations, for the rank of Lieutenant, shall also be extended to the Examination of Officers for the rank of Master, with the exception of the knowledge of French; and the Regulations in regard to the rejection of Candidates shall equally apply to them. Officers passing for the rank of Master will not be required to pass a Gunnery Examination.

XXII. With reference to Circular No. 97., of the 9th December, 1851, — The foregoing Examination for the entry of Naval Cadets under 14 years of age shall be extended to Masters' Assistants, between 14 and 15 years of age; and the foregoing Examination for the entry of Cadets above 14 years of age, shall be extended to Masters' Assistants between 15 and 16 years of age. The knowledge of Latin, French, and English History, will not be required of Masters' Assistants at these Examinations.

XXIII. The Captains of H.M. Ships are to take care that a convenient place is set apart and proper hours are fixed for instruction by the Naval Instructor, and all Acting Mates and Acting 2nd Masters, as well as all executive Officers under that rank, are to attend, and care is also to be taken that they are regularly instructed in Practical Seamanship, Rigging, and the Steam Engine, and a Monthly Examination Day is to be established.

List of Instruments and Books which each Cadet will be required to have on entry :—

Sextant.
Case of Mathematical Instruments, containing a good protractor.
Spy Glass.
French Grammar and a Dictionary containing Sea Terms.
A Book on Navigation.
Euclid's Elements.
Book of Geography. (Sullivan's 2s. Ed.)
Book on use of Mathematical and Nautical Instruments.
A Book on the Steam Engine.
Colenso's Arithmetic and Algebra.
Jeans's Trigonometry.

The Ship's Library will contain Books of Instruction.

No. I.

The Examination on leaving the Training Ship will embrace all the subjects of the former Examination, except Latin, and in addition to them it will include

In Arithmetic—Involution, Extraction of Square Root.
In Algebra—Simple Equations.
The Elements of Geometry, as contained in the text-book published for the use of the Boys of Greenwich School, by John Murray, 1854.
Plane Trigonometry and the Solution of practical and useful Problems.
Spherical Trigonometry, the mode of Solving Triangles, and its application to Simple Astronomical Problems.
In Navigation — A Day's Work and Meridional Altitudes, Longitude by Chronometer.
Nautical Instruments. To explain and use the Sextant, Azimuth Compass, Artificial Horizon, and Theodolite.
Some knowledge of the mode of Surveying, and the Construction of Charts.
French, as far as 50 lessons of Ollendorff's method of learning French, and the reading and translating of an easy passage from a French author without the aid of a dictionary.

Explanatory Lectures will be given on the Steam Engine, practical Astronomy, Nautical Instruments, Mechanics, and Hydrostatics, and other subjects of general interest and instruction.

Certificates must be produced, approved by the Captain, from the Master of the Ship that the Candidate has gone through and is competent in the course of instruction in Rigging and Seamanship, and from the Naval Instructor as to the Candidate's attention to the various branches of his education, as well as to his general conduct whilst on board the Training Ship.

A.

Form of Certificate to be given to Officers on passing for Midshipmen, and at the intermediate Examination.

We hereby certify that Mr.
has served the required period of time with the following ratings in H.M. ships, as follows :—

And we find his professional knowledge to be—

In Seamanship,

In Gunnery,

In Navigation,

we consider him qualified and have granted him * class Certificate.

Candidate's Signature.

Date of Birth.

Signature of Examining Officers.

No. II.

Form of the Passing Certificate in Seamanship for the Rank of Lieutenant or Master.

In pursuance of an Order from we, whose names are hereunto annexed, have called before us Mr. and find, by his Certificate of Baptism, that he is of the proper age, as required by the Queen's Regulations; that he has served in the following Ships for the under-mentioned periods:—

Ships served in	Date of		Ratings.	Time served.		Remarks.
	Entry.	Discharge.		Y.	D.	

He produces Certificates of Good Conduct, for the period required by the Regulations, from the Officers under whom he has served; especially from

* 1st or 2nd.

We have *strictly inquired* into the said Mr.
professional knowledge in all the details of an Officer's and Seaman's duty, under the following heads, against each of which we have stated our opinions of his proficiency : —

I. State of his Log Book from the date of his first appointment to a Sea-going Ship, and if it contains Track Charts and sketches of Headlands, &c.

II. His Acquaintance with the Stowage of Ships' Holds.

III. Knowledge of Masting Ships, fitting Rigging and Sails, Rigging Ships, Mooring, and Unmooring, Shifting Masts' Yards, Laying out Anchors, Rigging Sheers, &c., and his practical knowledge of the details of a Seaman's duty in all its branches.

IV. As Officer of a Watch, the practice of Working and Manœuvring Ships under all circumstances of Wind and Weather, Shifting Sails, &c.

V.* Acquaintance with the name and use of the parts of the Engine, Boiler, &c. ; construction and principle of the Engine ; practical working of the Engine and Boiler.

VI. Date of Provisional Examination, and by whom.

NOTE. — The Examining Officers to state whether this Officer has any knowledge of the Flags and Signals and the manner of performing the Evolutions of a Fleet ; also of Stationing a Ship's Company.

And after a careful consideration of this Officer's examinatio
we are of opinion that he is † to take charg
of and perform the responsible duties of Officer of a Watch o

* When an Officer passes for Seamanship on the Home Station, his know ledge of steam need not be inquired into.

† Qualified or not Qualified,

board any of H.M. Ships, and is entitled to a*
class Certificate.

Given under our Hands at this day of

Captain, H.M.S.
Captain, „
Captain, „

Candidate's Signature at full Length - - - - } ______________________

Place where Born, Date of Birth, and Age on entering the Service - - - } ______________________

N.B. — In the case of an Officer passing for a Master, the Examination is to be conducted in the presence of a Captain or Commander by three Masters.

No. III.

Passing Certificate for a Lieutenant in Gunnery.

In pursuance of the Orders of the Lords Commissioners of the Admiralty, dated 23rd February, 1857, Mr.
belonging to H.M. Ship
has been examined in the following subjects connected with Naval Gunnery, against each of which is stated the opinion of his proficiency:—

I. Placing the Men at Quarters, and the established exercise of Great Guns, including the Revolving Gun Exercise.

II. Use of Tangent Sights, &c.

III. Charges, Elevations, and Ranges of the different Guns; the Stowage and Working of Magazines.

IV. Disparting Instructions, &c., and subjects connected therewith.

V. Fitting Fuses, and the use of Shells, also the mode of ascertaining the distance of a Ship at Sea.

VI. General questions on Naval Gunnery, as contained in the Gunnery Book.

VII. Cutlass and Small Arm Exercise.

* 1st, 2nd, or 3rd.

I consider him qualified, and recommend his being granted a* class Certificate.

Given under my hand, on board Her Majesty's Ship this day of 185

Approved,

Gunnery Officer.

Captain.

No. IV.

Form of Passing Certificate in Navigation for a Lieutenant or Master.

In pursuance of the Orders of the Lords Commissioners of the Admiralty, dated 23rd February, 1857, we have strictly inquired into the practical knowledge of Mr.
belonging to H.M. Ship
in the following subjects; against each we have stated our opinion of his proficiency:—

I. His knowledge of the theory and practice of Navigation and the mode of Conducting a Ship on a Voyage from one distant Port to another by Tables as well as by Projection.

II. If he can Observe and Work out the Latitude by the Meridional Altitudes of the Sun, Moon, and Stars.

Also by Double Altitude and the Pole Star.

III. Also, if he can Observe and Work out the Longitude by Chronometer, and find and apply the Error and Rate of the same.

Also by Lunar Observations.

IV. If he can Observe with the Azimuth Compass and find the Variation by Azimuth and Amplitude; likewise find and apply the corrections for the local attraction of the Compass; and if he understands the principle of these various subjects.

V. His knowledge of the man-

* 1st or 2nd.

ner of making the Survey of a Harbour, laying down Positions and Soundings, and use of Charts.

VI. His knowledge of the prevailing Winds of the Globe, and also the Currents of the Ocean; and if he can find the time of the Tides.

VII.* If he has a familiar acquaintance with the French language.

VIII. And if he has any knowledge of Mechanics and Hydrostatics.

IX. If he has any proficiency in Drawing.

X. The name and use of the parts of the Steam Engine and Boiler; construction and principle of the engine and boiler; practical working of the same, and use of the Indicator.

We find, after full investigation, that he is competent to navigate any of H.M. Ships, and is entitled to a †
class Certificate.

Captain of H.M.S. "Excellent," and Superintendent of the Royal Naval College.

Approved,

Admiral and Commander-in-Chief.

Professor of the Royal Naval College.

B.

Number of Observations required to be taken by a Candidate during the last six months of his Service, before he can be Examined at the Royal Naval College for the rank of Lieutenant or Master.

	No. of Obs.
1.—To find the index correction	
By Sea Horizon - - - - -	10
By measuring the Sun's diameter off and on the Arc - - - - - -	

* Although no other modern language than the French has been specified as a subject of examination, yet proficiency in any other language should be favourably noted in the Certificate. Officers passing for the rank of Master are not required to be examined in French.

† 1st or 2nd.

	No. of Obs.
2.—To find Latitude	
By altitude of Sun or Stars, near the Meridian -	5
By Meridian altitude of Sun - - -	10
By Meridian a'titude of Moon or Stars - -	10
By altitude of Pole Star - - - -	10
3.—To find Longitude by Chronometer	
By altitude of Sun - - - -	10
By altitude of Moon or Stars - - -	10
4.—To find variation of Compass	
By altitude of Sun and Compass bearing - -	5
By time at ship noted and Compass bearing -	3
By Amplitude - - - - -	5
5.—To find Latitude	
By double altitude of Sun or Stars - -	3
6.—To find Longitude	
By Lunar - - - - -	5
7.—To find error and rate of Chronometer by altitudes on shore with artificial horizon	
By single altitude - - - -	5
By equal altitudes - - - -	2

I hereby certify that Mr.
has observed and worked out the above number of Observations during the last six months, whilst serving in H.M. Ship

Naval Instructor.

Approved, If no Naval Instructor,

Captain. Master.

By command of their Lordships,

R. OSBORNE.

To all Commanders-in-Chief, Captains, Commanders, and Commanding Officers of Her Majesty's Ships and Vessels.

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